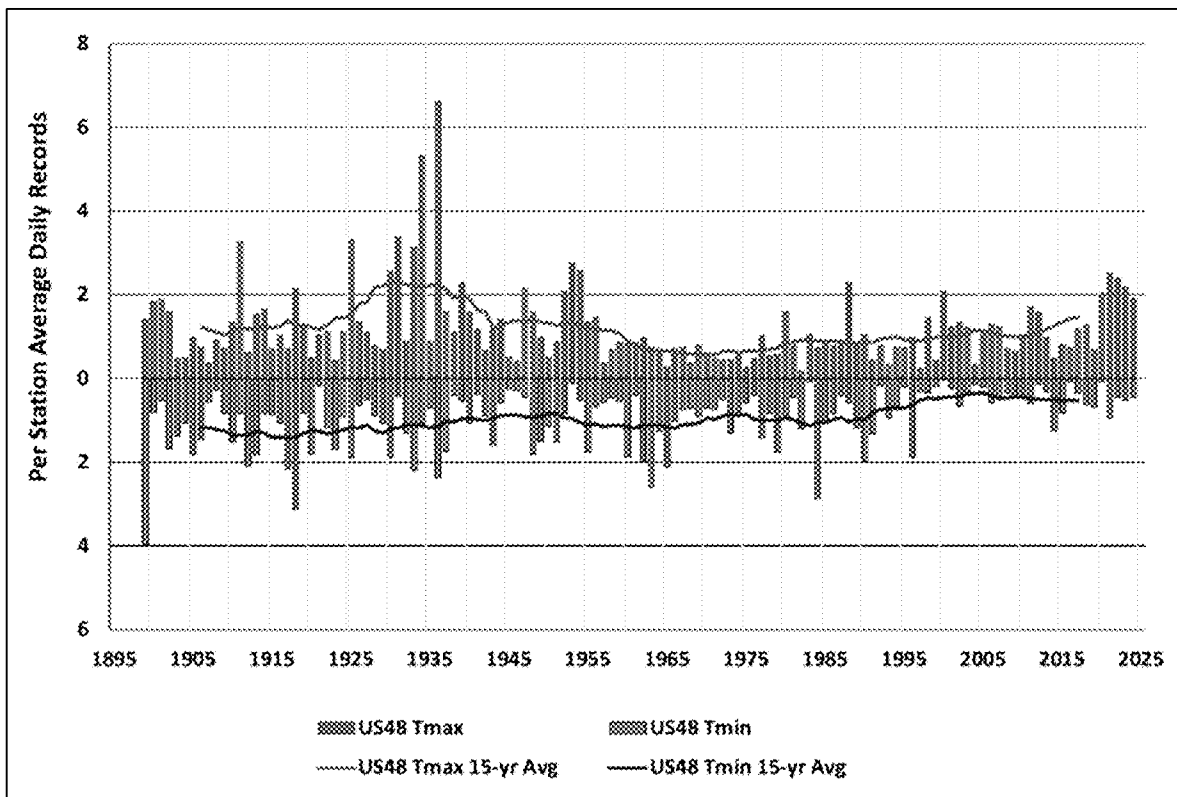




Number of daily record High (red) and Low (blue) temperatures for warm and cold seasons in the CONUS. The lines represent the 15-year running, centered average. Source: 1,211 USHCN stations supplemented as needed to achieve a minimum of 92 percent of observations in the 126-year period since Dec 1898. US48: contiguous U.S. states. Tmax: maximum temperature. Tmin: minimum temperature. Source: CWG25 Figure 6.3.3.

The National Academies' expert review panel criticized the discussion of temperature extremes in a late draft of the CSSR. In reference to the CSSR's Key Finding 2 of Chapter 6, they said:

Further, it is difficult to understand how a statement that includes increases in extreme warmth can be associated with a high confidence or extremely likely statement, given that most of the graphics in this chapter show a decrease in extreme warmth in the historical record.

The Federal official in charge of the CSSR (Michael Kuperberg, Executive Director of the USGCRP) responded to the Academies' review by noting that

Almost every recommendation from the NAS was incorporated [in the final version]... and a new figure was added on changes in record high and low temperatures

The "new figure" referred to is the Figure ES.5, which did not appear in the draft reviewed by the Academies' panel. It seems unlikely that the Academies panel ever saw that figure because they surely would have commented if they had and it wouldn't have survived to publication. And the

figure's problems were evidently not flagged (or were ignored) in the subsequent internal government reviews.

With this background we now present our critique of NCA5.

2 NCA5 OVERVIEW CHAPTER: HYPERBOLIC ADVOCACY LANGUAGE AND NON-SCIENTIFIC TONE

NCA5 Chapter 1 “Overview” holds a prominent place in the Report since it summarizes the whole report and is the only section that many will read. Although the later Chapters of NCA5 contain much sound scholarly content, Chapter 1 is marred by an activist tone and language that aggressively promotes emission reduction policies. As such, this chapter adds an imprimatur of scientific authority to oversimplified declarations of opinion about public policy. Many examples can be cited; here we note a few that are particularly egregious.

Chapter 1 opens as follows:

The more the planet warms, the greater the impacts. Without rapid and deep reductions in global greenhouse gas emissions from human activities, the risks of accelerating sea level rise, intensifying extreme weather, and other harmful climate impacts will continue to grow. Each additional increment of warming is expected to lead to more damage and greater economic losses compared to previous increments of warming, while the risk of catastrophic or unforeseen consequences also increases.

This statement presupposes that: all warming is anthropogenic in origin, all warming is bad and causes economic damage, warming causes extreme weather to intensify. Such sweeping generalizations go well beyond what science has or can establish. It also refers to growing risks without saying whether they were large to begin with: a small risk that grows may still be a small risk. A scientifically-sound version of this paragraph would instead say something like the following:

The Earth is warming because of a combination of natural and anthropogenic influences. This warming will generate a mix of benefits and harms that varies by region, to which society should be prepared to adapt. Some types of extreme weather have worsened recently, while others have not changed or have even declined in intensity. Reducing emissions of greenhouse gases might slow the warming although such policies have proven to be costly and disruptive, so any climate actions to be weighed against the potential benefits.

On the next page the Overview goes on to say:

Each additional increment of warming leads to greater risks [here it lists 7 key components of society including food security and the economy]... Without deeper cuts in global net emissions, climate risks to the US will continue to grow... Action to limit future warming and reduce risks can have near-term benefits and opportunities: low-carbon energy jobs, Improved air quality, Health benefits, Economic benefits...”

The authors write as if climate policy does not involve trade-offs and all measures to reduce future warming will be effective and beneficial. But the vast body of scholarship on climate science and economics does not support such simplistic claims. Not every additional increment of warming leads to economic harms, indeed (as is acknowledged in Chapter 19 on Economics) in some cases there will be benefits. Nor is climate policy guaranteed to create jobs or benefit the economy; in many cases it has done the opposite. Such deceit is a disservice to policymakers.

Pages 8 and 9 promote renewable energy options by noting, correctly, that the levelized costs of wind/solar generation have fallen sharply since 2010. This is proposed as rationale for pursuing deep emission reductions:

Recent growth in the capacities of wind, solar, and battery storage technologies is supported by rapidly falling costs of zero- and low-carbon energy technologies, which can support even deeper emissions reductions. For example, wind and solar energy costs dropped 70% and 90%, respectively, over the last decade, while 80% of new generation capacity in 2020 came from renewable sources.

Yet it has long been known that intermittent renewables generation must be supplemented by dispatchable generation to meet grid reliability standards, and that doing so (e.g., through natural gas, fission, or storage) can substantially increase the cost of electricity. Further, there are yet unmet synchronization challenges in transmission grids with heavy penetration of wind and solar power. Here again it is advisory malpractice not to acknowledge these facts.

Page 14 presents future emission scenarios with the following description: “Climate modeling experts develop global climate projections for a range of plausible futures.” The word “plausible” is applied to all the scenarios. The accompanying Figure includes both SSP3-7.0 and SSP5-8.5, the latter reaching the same radiative forcing as RCP8.5. The figure does not contrast observed emissions against previous projections nor does it caution readers that SSP3-7.0 and SSP5-8.5 are extreme worst case scenarios that, like RCP8.5, have been heavily criticized in the scientific literature (CWG25 3.2.1). By describing the entire envelope of emission projections as “plausible” the report opens the door to later presenting impacts associated with extreme and implausible emission scenarios as part of a baseline “business-as-usual” future.

Page 17 introduces the discussion of risks from extreme weather events by saying “Harmful impacts from more frequent and severe extremes are increasing across the country.” This creates the impression that disaster losses are driven by trends in extreme weather. While the section goes on to acknowledge that some of the increase is due to increases in the value of assets at risk it then invokes the NOAA Billion Dollar Dataset as evidence of extreme weather getting worse. Scientists have shown that this is an invalid metric (CWG 10.2) since it measures the growth of the economy not the frequency of extreme weather, and indeed NOAA has recently withdrawn the data product. Even though it was still distributed by NOAA at the time of the NCA5, the report authors should have assessed it skeptically and seen that it was unfit for the purpose of measuring climate trends and they should have taken care not to conflate extreme weather metrics with economic trends.

Page 23 states, in large font:

Climate changes are making it harder to maintain safe homes and healthy families; reliable public services; a sustainable economy; thriving ecosystems, cultures, and traditions; and strong communities.

It is pointless to try to evaluate this statement on scholarly grounds; it is self-evidently hyperbolic. This kind of language doesn’t belong in a scientific assessment report. Its prominent inclusion points not only to the willingness of NCA5 authors to promote hysteria, but also the ineffectiveness of the review process at not ensuring such statements are removed.

The tone of the Overview chapter hints at the priorities that governed the writing of the report as a whole. As a crude indicator of these priorities, word searches of the full document revealed the following occurrences:

Term	Number of occurrences
Forcing	111
Uncertainty	384
Watts	19
Culture/culturally	854
Equity/equitable	572
Indigenous	890
Sustainable	295
Racism/racial	153

3 OVERCONFIDENCE WHEN STATING CONCLUSIONS

3.1 Inflated certainty levels

A general pattern in the NCA5 is overconfidence in stating conclusions. The authors frequently make sweeping generalizations without appropriate caveats or acknowledging uncertainties. The overconfidence begins with inflated language to describe certainty levels.

The NCA5 uses specific terms to convey information about scientific confidence associated with important finds, observations and projections. The Front Matter of the NCA5 states that “confidence in a finding is based on the type, amount, quality, strength, and consistency of evidence; the skill, range, and consistency of methods to detect, evaluate, attribute, and interpret climate trends; and the degree of agreement across scientific information sources.”

Table 1 from the Front Matter provides calibrated language for confidence assessment:

Very high:	Strong evidence (established theory, multiple sources, well documented and accepted methods, etc.). High consensus
High:	Moderate evidence (several sources, some consistency, methods vary and/or documentation limited, etc.). Medium consensus
Medium:	Suggestive evidence (a few sources, limited consistency, methods emerging, etc.) Competing schools of thought.
Low:	Inconclusive evidence (limited sources, extrapolations, inconsistent findings, poor documentation and/or methods not tested, etc.). Disagreement or lack of opinions among experts.

This terminology is inflated: *high confidence* with just moderate evidence and medium consensus; *medium confidence* with only suggestive evidence and competing schools of thought. This inflation in terminology leads to overconfidence in the conclusions.

Even within the context of this inflated terminology, NCA5 further inflates the confidence level of many of its conclusions to well beyond what the IPCC has concluded with more thorough justification, and also by incorrectly applying its own standards. Several illustrative examples are provided.

Key Message 3.1 Traceable Account states:

“There is *very high confidence* that emissions of GHGs from human activities, fossil fuel use in particular, have unequivocally caused *all* global warming observed over the industrial era.”

Compare this statement with statements from the IPCC AR5 and AR6:

AR5: “It is *extremely likely* that *more than half* of the observed increase in global average surface temperature from 1951 to 2010 was caused by the anthropogenic increase in greenhouse gas concentrations and other anthropogenic forcings together.” (IPCC, 2013)

AR6: The *likely* range of total human-caused global surface temperature increase from 1850–1900 to 2010–2019 is 0.8°C to 1.3°C, with a best estimate of 1.07°C. It is *likely* that well-mixed GHGs contributed a warming of 1.0°C to 2.0°C, other human drivers (principally aerosols) contributed a cooling of 0.0°C to 0.8°C, natural drivers changed global surface temperature by –0.1°C to +0.1°C, and internal variability changed it by –0.2°C to +0.2°C. It is *very likely* that well-mixed GHGs were the main driver of tropospheric warming since 1979.

The IPCC AR5 and AR6 statements provide likelihood assessments but not a confidence level. While the NCA5 claims with *very high confidence* that fossil fuels have unequivocally caused *all* global warming, the AR5 refers to “*more than half* of the observed warming” and the AR6 provides a more nuanced statement that relates to a *likely* range of warming contributed to by human drivers.

NCA5 Key message 2.2: “Hurricanes have been intensifying more rapidly since the 1980s (*high confidence*) and causing heavier rainfall and higher storm surges (*high confidence*).” No justification is provided in Chapter 2 for the *high confidence* conclusion on higher storm surges or hurricanes causing heavier precipitation. The Traceable Accounts section, Description of Confidence and Likelihood states:

Basic physical understanding and climate models both provide robust explanations for the links between climate change and observed changes in these extremes: this is why the authors also have *high confidence* that storms are delivering more rainfall and high confidence that storm surges are becoming higher.

In short, NCA5 provides no observational basis or published research for their *high confidence* assertions that hurricanes are causing heavier rainfall and higher storm surges; and does not meet its own standards for a *high confidence level*.

3.2 Overstating findings in underlying sources

Although we did not do a detailed audit of the NCA5’s use of source material, spot checks turned up evidence of a pattern of overstatement.

Chapter 2 page 11 reports on an increase in precipitation in some areas and attributes it to climate change:

Many eastern regions of the country are getting wetter (Figure 2.4). Average annual precipitation from 2002-2021 was 5%-15% higher relative to the 1901-1960 average in the central and eastern US, a trend attributable to climate change.

Note that this is a non-standard metric; we will discuss NCA5's inconsistent choices of time scales of analysis below. The claims were attributed to the following paper:

- Knutson, Thomas and Fanrong Zeng (2018) "Model Assessment of Observed Precipitation Trends over Land Regions: Detectable Human Influences and Possible Low Bias in Model Trends" *Journal of Climate* 31(12)
<https://journals.ametsoc.org/view/journals/clim/31/12/jcli-d-17-0672.1.xml>

But Knutson and Zeng did not say these things. They examined linear trends over 1901 – 2010, 1951 – 2010 and 1981 – 2010. They did not compare average rainfall over 2002 - 2021 to average rainfall over 1901 – 1960, indeed their study was published in 2018 so it could not have. With regard to 1981-2010 trends they noted stronger trends in some areas but cautioned that such changes are consistent with natural variability, and they did not claim attributable trends were observed over the United States:

Observed annual precipitation trends over the recent 30-yr period 1981–2010 (Fig. 5) have generally stronger magnitudes (in mm yr⁻¹ decade⁻¹) than observed trends for 1901–2010 or 1951–2010. This is as expected since trends over a shorter period have stronger potential for occurrence of pronounced temporary trends due to internal variability alone. Only 9% of the analyzed area has detectable and attributable anthropogenic influence (categories –3, –2, +2, +3), which represents less than one-third of the fractional areal coverage of such trends for 1901–2010 (29%). ... Eight percent of the analyzed area has attributable anthropogenic *increases* (categories +2, +3), including parts of eastern Europe, northern Asia, northern Australia/Maritime Continent, and tropical Africa.

Consider a 2nd example. NCA5 Chapter 2 page 18 states

There is robust evidence that human-caused warming has contributed to increases in the frequency and severity of the heaviest precipitation events across nearly 70% of the US.

This is attributed to two papers:

- Diffenbaugh, N.S., D. Singh, and J.S. Mankin, 2018: Unprecedented climate events: Historical changes, aspirational targets, and national commitments. *Science Advances*, 4 (2), 3354.
<https://doi.org/10.1126/sciadv.aao3354>
- Kirchmeier-Young, M.C. and X. Zhang, 2020: Human influence has intensified extreme precipitation in North America. *Proceedings of the National Academy of Sciences of the United States of America*, 117 (24), 13308-13313. <https://doi.org/10.1073/pnas.1921628117>

Diffenbaugh et al. presented ratios of observed occurrences of extreme events to simulated occurrence rates in CMIP6 models run with only natural forcings. They report that for 79% of the U.S. extreme rainfall event frequencies are currently higher than in model simulations, and the ratio of occurrences will rise under future warming simulations. This is not “robust” evidence of anthropogenic influence since it requires readers to assume that climate models provide accurate simulations of regional precipitation patterns, something which even the IPCC AR6 admits is uncertain (AR6 WGI SPM Box SPM 1.2, SPM Section C.1.3).

Kirchmeier-Young and Zhang looked at extreme 1- and 5-day events in North America and, using 3 GCMs, found “A signal of combined anthropogenic and natural external forcing can be detected in the intensification of extreme precipitation at the continental scale over North America. In some cases, this intensification can be attributed to human influence specifically.” However, they noted large differences among the three models in their simulated precipitation changes. Also, 2 of the 3 models failed to yield attribution for 5-day events for the North America mean, in other words the models disagreed on whether the observed changes were due to anthropogenic activity. Both cited references utilized the implausible RCP8.5 scenario and began their “historical” observational records only in 1961. Here again this is not “robust” evidence, it is suggestive but other studies have found natural variability predominant.

3.3 Technical example: Emergent constraints

Some of the overconfidence expressed by NCA5 arises by leaving out discussion of counterevidence in the peer-reviewed literature. An example is the topic of “emergent constraints”. Chapter 3 page 17 invokes this concept as grounds for its claim that key uncertainties have been reduced:

An approach to reduce uncertainty in climate change projections has matured over the past decade. It is known as “emergent constraints.” The term refers to strong statistical relationships between highly uncertain future climate parameters and observable trends or variations in the current climate, along with a physical explanation of this relationship.

Emergent constraints appeared in the climate modeling literature as an attempt to tie GCM behavior to climate observations in hopes of generating insight into real-world ECS. Climate models exhibit a wide range of sensitivities. The idea of emergent constraints is to examine whether the models with shared sensitivity values also share a common representation of some climate process (usually related to clouds) that might indirectly influence ECS. Suppose, for instance, that in low-ECS models the total cloud fraction in the tropics is strongly correlated with that in the southern midlatitudes but in high-ECS models the correlation is weak. Then researchers could check if the observed correlation is strong or weak and draw a conclusion about which type of model, and therefore which ECS value, is more likely.

A problem in the emergent constraint literature is that there has been a large proliferation of proposed correlations with little physical motivation. Many emergent constraints patterned on CMIP5 models failed to work on CMIP6 models (Schlund *et al.* 2020)³. In other words, the observed correlations in CMIP5 models between ECS and cloud processes failed to show up in CMIP6 models, indicating that they were likely spurious rather than clues to physical processes governing the Earth

³ Schlund, Manuel, Axel Lauer, Pierre Gentine, Steven C. Sherwood, and Veronika Eyring (2020) Emergent constraints on equilibrium climate sensitivity in CMIP5: do they hold for CMIP6? *Earth System Dynamics* 11 1233-1258 <https://doi.org/10.5194/esd-11-1233-2020>

climate system. The result was that emergent constraints estimated on CMIP5 models widened the range of estimated ECS values when applied to CMIP6 models.

Schlund *et al.* summarized the problem as follows:

In this study, we systematically analyze 11 published emergent constraints on ECS that have mostly been derived from models participating in the Coupled Model Intercomparison Project Phase 5 (CMIP5) project... The focus of the study is on testing if these emergent constraints hold for [Earth System Models] participating in the new Phase 6 (CMIP6). Since none of the emergent constraints considered here have been derived using the CMIP6 ensemble, CMIP6 can be used for cross-checking of the emergent constraints on a new model ensemble. **The application of the emergent constraints to CMIP6 data shows a decrease in skill and statistical significance of the emergent relationship for nearly all constraints, with this decrease being large in many cases.** Consequently, the size of the constrained ECS ranges (66% confidence intervals) widens by 51% on average in CMIP6 compared to CMIP5.

Yet NCA5 described the use of emergent constraint analysis as a great “advance” that reduced uncertainty.

4 RELIANCE ON *Ad Hoc* TIME SCALES FOR TREND ANALYSIS

In CWG25 Chapter 6 we discussed the need to be careful regarding the choice of time scale when making claims about trends in extreme weather. We gave examples from analysis of river flooding (6.1), heatwaves (6.3) and extreme precipitation (6.4) to show how assertions about apparent trends based on short data sets fall apart when looking at longer versions of the same data sets. Here we elaborate on these examples to illustrate a general point that NCA5 made inconsistent and *ad hoc* choices about time scales of analysis, weakening the validity of their conclusions.

McKittrick and Christy (2019)⁴ showed that apparently significant positive trends in U.S. average and extreme precipitation over the NCA4 interval (1901 – 2016) disappeared on longer samples (extending back as far as the 1840s depending on location) or on a shorter interval coinciding with the final 40 years of the data then available (1978 – 2017).

In CWG Section 6.4 we presented analysis of updated data for the same locations and many more besides, in all cases finding both considerable regional heterogeneity and that trends detectable on one time scale are often not detected on longer or shorter time scales, which argues against simple attribution of changes to anthropogenic influences.

4.1 Average and Extreme Precipitation

Under Key Message 2.2 “Extreme Events Are Becoming More Frequent and Severe” (p. 2-16) NCA5 states (p. 2-18):

Rainfall is becoming more extreme

Since the 1950s, there has been an upward trend in heavy precipitation across the contiguous US. This increase is driven largely by more frequent precipitation extremes, with relatively smaller changes in their intensity.

NCA5 did not continue the NCA4 precedent of using the post-1901 interval as the time scale for its precipitation discussion, instead it refers to changes “since the 1950s”. Fig. 2.8 suggests 1958 as the start date. For the present report we have extended the CWG25 analysis even further to include 141 stations across the US in the Pacific Coast, Midwest, Northeast and Southeast regions. We provide details in Appendix XX; here we note merely that once again it is possible to find trends that support the NCA5 position, but they are not robust to selecting longer or shorter time scales of analysis. Data from 1950 to 2024 yields many indications of increased average and extreme precipitation at individual stations and region-wide averages. But when using the entire data set (back to the 1890s or earlier depending on location) or the later subset (1980 to 2024) the trends become smaller, in many cases they become statistically insignificant, and occasionally they change sign. Only in the Northeast region are the post-1950 trends robust to also focusing on the post-1980 interval.

The following is a more accurate summary of what U.S. data show.

⁴ McKittrick, R., and J.R. Christy (2019). Assessing changes in US regional precipitation on multiple time scales. *Journal of Hydrology*, 578, 124074. <https://doi.org/10.1016/j.jhydrol.2019.124074>

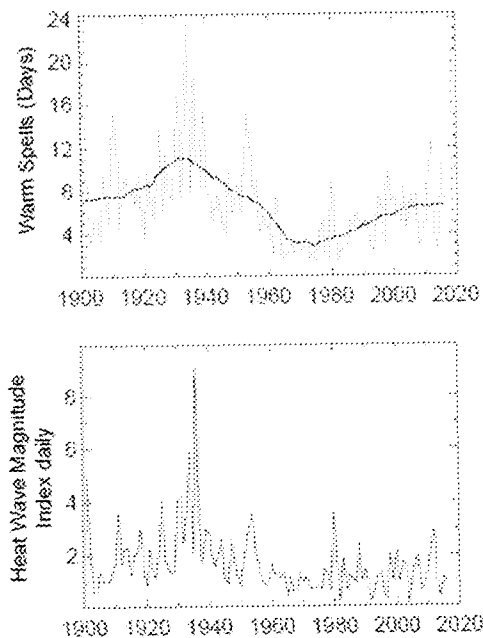
There are regionally-heterogenous changes in average and extreme precipitation. Positive trends in annual average rainfall and extreme events (defined either as the annual maximum or the number of exceedances of the 99th percentile value) are generally weak or non-existent when looking at samples exceeding 130 years in length. Significant trends can be found when beginning the sample in the 1950s although in most cases the trends weaken and become insignificant when looking at the post-1980 interval. This makes attribution to anthropogenic warming difficult.

4.2 Heatwaves

In contrast to NCA5, NCA4 examined heat extremes across the whole of the 20th century, pointing out that peak heat wave activity was reached in the 1930s and has decreased since then, and that recent increases are confined to areas west of the Rockies:

[The] warmest daily temperature of the year increased in some parts of the West over the past century, but there were decreases in almost all locations east of the Rocky Mountains. In fact, all eastern regions experienced a net decrease, most notably the Midwest (about 2.2°F [1.2°C]) and the Southeast (roughly 1.5°F [0.8°C]).

Since the mid-1960s, there has been only a very slight increase in the warmest daily temperature of the year (amidst large interannual variability). Heat waves (6-day periods with a maximum temperature above the 90th percentile for 1961–1990) increased in frequency until the mid-1930s, became considerably less common through the mid-1960s, and increased in frequency again thereafter. As with warm daily temperatures, heat wave magnitude reached a maximum in the 1930s. (NCA4 pp. 190-191)



U.S. Heat waves since 1900. Source: NCA4 Figure 6.4

Contrast this careful and factual language with NCA5 Key Message 2.2: “Extreme Events Are Becoming More Frequent and Severe.” This blanket statement is followed by NCA5 Figure 2.7 reproduced below.

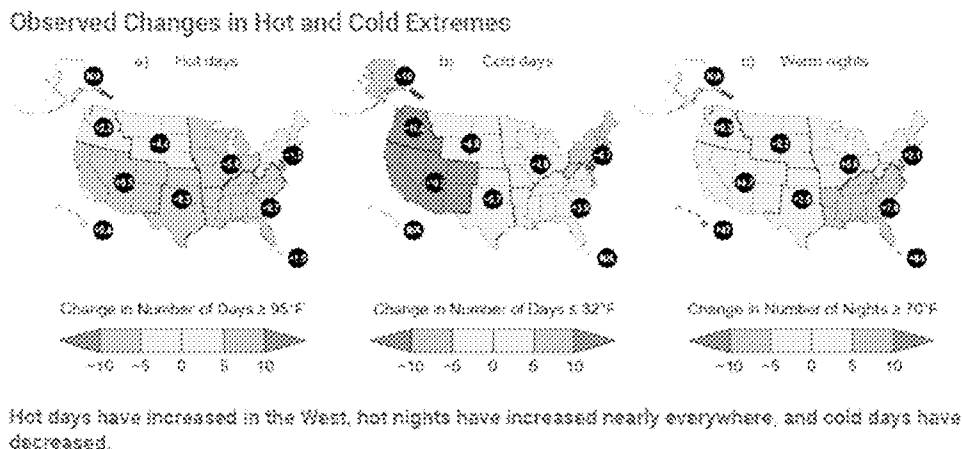


Figure 2.7. Over much of the country, the risk of warm nights has increased while the risk of cold days has decreased. The risk of hot days has also increased across the western US. This figure shows the observed change in the number of (a) hot days (days at or above 95°F), (b) cold days (days at or below 32°F), and (c) warm nights (nights at or above 70°F) over the period 2002–2021 relative to 1901–1960 (1951–1960 for Alaska and Hawaii and 1956–1980 for Puerto Rico). Data were not available for the US-Affiliated Pacific Islands and the US Virgin Islands. Figure credit: Project Drawdown, Washington State University Vancouver, NOAA NCIE, and CIRES NC.

Close inspection shows that this Figure contradicts the NCA5 Key Message with respect to heatwaves and instead reinforces the position of the NCA4. The time scale of analysis for this Figure is stated as the number of hot days, cold days and warm nights (respectively in panels a—c) over the period 2002-2021 compared to 1901-1960. Presumably (though not stated in the caption) the counts are per year. Notwithstanding Key Message 2.2 the leftmost panel shows that over most of CONUS the number of extreme heat days has decreased in recent decades compared to the prior century.

The accompanying discussion in NCA5 becomes convoluted since it appears to be aimed at supporting the Key Message despite the contrary evidence. NCA5 chapter 2 elaborates on KM2.2 by saying (p. 16):

Observations show an increase in the severity, extent, and/or frequency of multiple types of extreme events. Heatwaves have become more common and severe in the West since the 1980s (*high confidence*).

But it does not mention the decline elsewhere. On the next page (p. 17) it says:

By some measures, the most extreme heatwaves on record in the United States occurred during the Dust Bowl era of the 1930s. ... Globally such heatwaves are becoming more frequent, and in recent decades the western United States has been following those trends.

Reference to a global trend seems to be an attempt to tie heatwaves to climate change, but then the obvious question, unaddressed by NCA5, is why only part of the U.S. follows it while most of the

country is trending in the opposite direction. These issues were addressed in CWG25 Ch6, demonstrating that the range and magnitude of extreme temperatures (10s of degrees) are driven more by natural variability than the small extra forcing from the enhanced concentrations of CO₂. The data shown in CWG25 shows that in terms of both (a) hot days ($\geq 95^{\circ}\text{F}$) and (b) number of days in heatwaves, the current decade is experiencing no more than was experienced 100 years ago. For example, in the 30-year period 1925-1954, representing only 23% of the 1899-2024 data record, the CONUS experienced 33% of the total heat wave days. The most recent 30-years experienced 24%, almost exactly that expected by chance. Thus, the NCA5 claim that “multiday heatwaves have become hotter, more frequent, larger, and longer lasting in recent decades,” is seen to be simply false when expanding the temporal and spatial domains to encompass all available data (Ch6 Fig. 6.3.6 CWG25).

The NCA5 then pointed to the dramatic Pacific Northwest heatwave of 2021. CWG Section 8.6.1 discussed this event in detail, reviewing the findings of multiple peer-reviewed studies that explained the unusual meteorological conditions giving rise to it were unrelated to climate change, a point omitted from the NCA5 discussion.

NCA5 finally turns to the declining heatwave trend in CONUS east of the Rockies but attempts to reframe it by focusing on urban warm spells.

[The] number of very hot days has actually decreased across the central and eastern regions due to summer cooling trends in the region (Figure 2.7; Ch. 22). This does not, however, mean the central and eastern US are not affected by heat. The impacts of extreme high temperatures are more severe if such conditions persist for several days, and overall, multiday heatwaves have become hotter, more frequent, larger, and longer lasting in recent decades. Across 50 large US cities, the US Global Change Research Program heatwave indicator (<https://www.globalchange.gov/indicators/heat-waves>) shows that the average number of heatwaves has doubled since the 1980s, and the length of the heatwave season has increased from about 40 days to about 70 days.

We discussed this issue in CWG25 Section 6.3. The Figure referenced by NCA5 uses an *ad hoc* definition of heat wave, namely two consecutive days with minimum nighttime temperatures above the 85th percentile, and an *ad hoc* time scale which begins in the 1960s, the coldest decade in the last century, thus suppressing any comparison to the 1930s. Nighttime temperatures in urban areas have gone up faster than daytime temperatures (which the NCA5 acknowledges), but this is a signature of urban heat island effects and is not a good metric of climate change. CWG25 noted as well that the occurrence of hot days ($\geq 95^{\circ}\text{F}$) has recently increased in the West, but declined in the remainder of the country, and in the nationwide average, since 1899.

5 INADEQUATE TRACEABLE ACCOUNTS

Starting with the NCA3, the NCA has included a section on Traceable Accounts at the end of each Chapter. This is the description from the NCA5:

Each chapter concludes with a section entitled Traceable Accounts, which provides information on the overall process used to develop the chapter as well as a separate Traceable Account section for each Key Message. These Traceable Accounts describe the supporting evidence behind each Key Message, the process and rationale authors used in reaching their conclusions, and the author team's expert assessment of the confidence in and, where applicable, likelihood of these conclusions. As such, Traceable Accounts provide information about the state of the science, document sources of uncertainty, identify research gaps, and allow traceability to data and resources.

The Traceable Accounts for each Chapter and Key Message includes the following sections:

- Description of Evidence Base
- Major Uncertainties and Research Gaps
- Description of Confidence and Likelihood

The Traceable Accounts are in principle an important factor in addressing the NCA's statutory requirement to discuss scientific uncertainties. Further, the Traceable Accounts can help satisfy the Executive Order for Restoring Gold Standard Science with regards to: reproducibility, transparency, communication of error and uncertainty, and skepticism of findings and assumptions. However, the execution of the Traceable Accounts is uneven, often superficial and noninformative in Chapters 2 and 3 (which were the only Chapters investigated here). Here is an example from Key Message 2.2: Extreme Events are Becoming More Frequent and Severe.

The Description of the Evidence Base consists of two paragraphs, with the first paragraph summarizing the findings and the second paragraph providing a generic description of the types of data that can be used for storms. Major Uncertainties and Research Gaps focuses on the uneven distribution across US populations due to differences in exposure and vulnerability. The only limitations in data referred to are the lack of a long-term record of lightning, and the lack of homogenized daily and hourly temperature data except from reanalysis products.

The most astonishing deficiency is in the Description of Confidence and Likelihood. One of the statements in Key Message 2.2 is:

Hurricanes have been intensifying more rapidly since the 1980s (high confidence) and causing heavier rainfall and higher storm surges (high confidence).

The Description of Confidence and Likelihood includes the following statement:

Basic physical understanding and climate models both provide robust explanations for the links between climate change and observed changes in these extremes: this is why the authors also have high confidence that storms are delivering more rainfall and high confidence that storm surges are becoming higher.

No reference to journal publications or a specific data set is made in the Chapter regarding hurricane induced precipitation or storm surge to support this *high confidence* conclusion.

With regards to Chapter 3, there are some substantial inconsistencies between the Traceable Accounts for the different Key Findings:

Key Message 3-1: Human activities have caused global warming.

Confidence and Likelihood: “There is *very high confidence* that emissions of GHGs from human activities, fossil fuel use in particular, have *unequivocally* caused all global warming observed over the industrial era. There is also *very high confidence* that changes in natural climate drivers have had globally small and regionally variable long-term effects over this period.”

The Uncertainties section only addresses uncertainties in radiative forcing of greenhouse gases. By contrast, consider Key Message 3-4: “Humans are changing Earth System processes.” The Traceability Analysis in this section contains arguably the most scientifically credible text in the entire Chapter. From Description of Evidence Base:

In the last decade, there has been increasing recognition of the role of regional-scale natural variability in the past and future evolution of climate, as well as the fact that regional natural variability signals can be competitive with forced anthropogenic signals.

From Major Uncertainties and Research Gaps:

For example, the true natural variability of the climate system on decadal to centennial timescales could be larger than what we estimate from GCMs, which would further increase the irreducible uncertainty stemming from natural variability.

As part of the Traceable Account: “Each figure and some tables are accompanied by a metadata survey, which can be accessed in the online version of the report by clicking on the eyeball icon above the figure or table (see the table below for explanations of additional icons used throughout the report). The metadata survey describes data sources, figure or table development methods, copyright information, and other important documentation.” Upon clicking on the eyeball icon above a particular figure, a Contact US email appears, addressed to the USGCRP. No attempt was made to send a email to elicit the Metadata information, but it is clear that this information is not readily accessible online.

In summary, the Traceable Analyses examined here, with few exceptions, fail to meet the stated objectives set forward by the NCA.

6 OVEREMPHASIS ON EXTREME SCENARIOS

To respond to the GCRA mandate to “project major trends for the subsequent 25 to 100 years,” the NCA relies on projections of future climate change based on estimates of future emissions (the so-called SSP scenarios) and/or specified levels of radiative forcing (the RCP scenarios). For the most part, NCA5 uses scenarios developed for the IPCC Assessment Reports.

In CWG Section 3.2.1 we presented a critical assessment of past and current IPCC scenario envelopes, showing that they have tended to overshoot observed emissions. The IPCC AR6 published in 2021 stated that “The likelihood of high-emission scenarios like RCP8.5 and SSP5-8.5 is considered low in light of recent energy sector developments.” In 2021, UN Climate Negotiators (COP) stopped using scenarios above 4.5. NCA5 makes the following observations about the scenarios they use:

“NCA5 authors were advised to assess the full range of scenarios available.” (Front Matter)

“Scenarios of future emissions and land-use change are developed as plausible alternatives, but no relative likelihood is attached to them. Some recent studies, however, have argued that the highest scenario, SSP5-8.5, is no longer plausible without a reversal of current trends in the adoption of renewables and energy efficiency.” (Key Message 3.3 Traceable Analysis)

Despite acknowledging the issue the NCA5 otherwise ignored the problem. A keyword search of the NCA5 of mentions of RCP/SSP scenarios finds over 50% referred to the extreme emissions scenarios RCP8.5/SSP5-8.5. Further, 10 figures *only* included the 8.5 scenarios: 5.2, 6.9, 7.4, 11.3, 14.6, 22.13, 22.19, 27.9, 29.13.

The problem of relying on extreme scenarios is particularly acute for NCA5’s sea level rise projections. The sea level rise scenarios used in the NCA5 do not relate directly to the SSP emissions scenarios, but to specified amounts of sea level rise by 2100, whereby Low relates to 0.3 m (0.98 feet), Intermediate-Low relates to 0.5 m (1.64 feet), Intermediate relates to 1.0 m (3.28 feet), Intermediate-High relates to 1.5 m (4.92 feet), and High relates to 2.0 m (6.56 feet). (Table 4 of Guide to Using this Report).

Table 4. Descriptive Terms for Common Sea Level Rise Scenarios Used in NCA5

Future global mean sea level rise and sea level rise along United States coastline are shown for five scenarios in feet (and meters), relative to a 2000 baseline. The US values shown in the right half of the table are averaged across the US coastal regions, including the contiguous US, Alaska, Hawaii and the US-Affiliated Pacific Islands, and the US Caribbean. The national values shown in the table differ substantially from regional values. For example, sea level rise is higher in the Gulf Coast and lower or even negative in some parts of Alaska. In the next 10 years (2020–2030), sea level along the contiguous US coasts is expected to rise 0.92 feet (0.28 m), the same amount of sea level rise observed over the last 100 years (1920–2020). See Chapter 9 for regional sea level information. Adapted from Sweet et al. 2022.¹

Sea Level Rise Scenario Descriptor	Global Mean Sea Level			United States		
	2050	2100	2150	2050	2100	2150
Low	0.49 (0.15)	0.98 (0.3)	1.31 (0.4)	0.59 (0.18)	0.98 (0.3)	1.64 (0.5)
Intermediate-Low	0.66 (0.20)	1.64 (0.5)	2.62 (0.8)	0.75 (0.23)	1.64 (0.5)	2.95 (0.9)
Intermediate	0.92 (0.28)	3.28 (1.0)	6.23 (1.9)	0.89 (0.27)	3.28 (1.0)	6.89 (2.1)
Intermediate-High	1.21 (0.37)	4.92 (1.5)	8.86 (2.7)	1.12 (0.34)	4.92 (1.5)	8.86 (2.7)
High	1.41 (0.43)	6.56 (2.0)	12.14 (3.7)	1.38 (0.42)	6.56 (2.0)	12.46 (3.8)

CAPTION NEEDED

The text following is Judy's latest edit

Considering only projections representing processes quantified with at least medium confidence, the IPCC AR6 assessed global mean sea level projections for 2100 to fall between 0.2 and 1.6 m (5th—95th percentile range). Nevertheless, the range of sea level rise scenarios considered by the NCA5 extends to 2.0 m. Further, the NCA5 neglects to include plausible lower scenarios, such as 0.2 m cited by the IPCC, which also corresponds to the average rate of sea level rise over the past century.

With regards to actual predictions of sea level rise, Chapter 9 of the NCA states: “Under a range of potential global warming levels, average sea level along US coastlines is *likely* to be between 12 and 20 inches above 2000 sea levels in 2050.” These values of sea level rise encompass the Intermediate scenario to values slightly higher than the High scenario from NCA5 Table 4 shown above.

Global sea level rise projections to 2050 relative to a 2000 baseline can be evaluated with respect to the observed global sea level rise from 2000-2024, which is approximately 3.39 inches (0.28 feet). <https://www.climate.gov/news-features/understanding-climate/climate-change-global-sea-level> Hence NCA5 is projecting values of sea level rise between 2025 and 2050 that are 3.5 to 5.8 times the rate observed during 2000-2024.

Chapter 9 further states: “Looking toward the future, an 11 inch (28 cm) average rise along the contiguous US coastline is expected by 2050 (relative to 2020), with a *likely* range of 9-13 inches.” With regards to confidence levels, NCA5 Chapter 9 Traceable Accounts states: “There is *high confidence* and it is *likely* that sea levels will rise about 11 inches (likely range of about 9–13 inches) between 2020 and 2050”

In summary, the NCA5 presents future sea level rise scenarios that are not directly relatable either to SSP/RCP emissions scenarios or Global Warming Levels. The NCA5 scenarios include some that are higher than the 95th percentile for the extreme emissions scenario RCP8.5 that include hypothesized ice sheet processes for which there is low confidence. Projections to 2050 require rates of sea level rise from 2025 to 2050 that are more than three times the rate observed during 2020-2024. Further, the NCA5 ascribes *high confidence* to these sea level rise projections.

In summary, the NCA5 inclusion, and even the focus, on implausible extreme emissions scenarios supports projections of alarming impacts that are very unlikely to be driven by anthropogenic warming.

7 INADEQUATE NASEM REVIEW: TO BE ADDED

The National Academies of Science, Engineering and Medicine (NASEM) undertook a detailed review of the draft NCA5 (NASEM 2023).⁵ While they raised some of the concerns we have articulated herein their review is superficial overall and appears to be written by authors who share many of the activist

⁵ National Academies of Sciences, Engineering, and Medicine. 2023. *Review of the Draft Fifth National Climate Assessment*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/26757>.

biases of the NCA5 team. There is an inordinate focus on on social and policy issues (e.g., every chapter is assessed under the heading “Comments on Equity and Justice”), rather than on the underlying science. In our assessment NASEM failed to apply the serious rigor one would expect. A few extracted comments from it will illustrate. Note that NASEM review comments are included here in blue font for reference.

7.1 Substantive criticisms by NASEM

- summarize the valid points made by NASEM and check the NCA replies

7.2 Failures to challenge NCA5 flaws

NASEM praised Chapter 2, saying:

The chapter [2] meets the requirements of Section 106 of the GCRA.

Yet contrary to the requirements of Section 106 the NCA5 did not discuss natural variability let alone assess the full climate record available for quantifying natural variability. Chapter 2 actually minimizes natural variability by claiming (unsubstantiated) skill in attributing recent extremes to human causes. For example NCA5’s Chapter 2 Introduction states,

“...recent advances in attribution science (KM 3.3) mean that the role of climate change in some extreme events can now be quantified in real time. For example, climate change made the record-breaking Pacific Northwest heatwave of June 2021 2° to 4°F hotter, and in 2017 ...”

CWG25 reviews the expert literature demonstrating that this particular event would have happened with or without climate change and that for the CONUS, hot extremes are no more frequent now than they were in the past. NASEM did not challenge the unsubstantiated attribution claims in the NCA5.

Notwithstanding NASEM’s claim that the Chapter complies with Section 106 of the GCRA it then acknowledged the absence of discussion of natural variability:

...the discussion and references regarding the role of natural climate variability and its regional differences are missing.

While a nod to natural variability is occasionally found in NCA5, it is usually followed by a “however” to emphasize human influence. One example is the statement just before the claim mentioned above pertaining to extreme event attribution: “There has always been extreme weather, which occurs even in an unchanged climate due to the natural variability of the Earth system. However, recent advances in attribution science (KM 3.3) mean that the role of climate change in some extreme events can now be quantified in real time...”

We pointed out that the evidence regarding heatwaves directly contradicts Key Message 2.2. NASEM did not mention this, instead it focused on a somewhat esoteric issue of terminology:

“Extreme Events Are Becoming More Frequent and Severe.”

Key Message 2.2 is another generally well written key message. However, while the title of this key message includes the word “risk,” the key message is exclusively about hazard. The Committee suggests rewriting the key message title to more accurately reflect the discussion on hazards.

The NASEM review appears to accept the NCA5’s use of short data records because it makes no critical remarks about the failure to assess long time series, except for its observation that the use of short records makes the omission of natural variability that much more of a problem:

It is also important to point out that the influence of natural climate variability becomes particularly strong when the climate trend is computed based on short periods of time or small geographic areas.

This comment was largely ignored in the NCA5 final text.

8 SUMMARY: EVALUATION OF THE NCA5

8.1 Pertinent aspects when evaluating NCA5 in light of statutory requirements

- not our remit to make a ruling but here are aspects to consider in light of statutory requirements

8.2 Evaluation from the perspective of expert users of the report

- we have deep knowledge of the topics surveyed by the NCA5 authors
- we do not have confidence that the report was balanced and comprehensive
- we can point to many specific instances in which the report did not exhibit an appropriate level of quality or integrity as a scientific document
- we have reason to believe the whole process, from author selection to handling of expert reviews, was biased towards reinforcing foregone conclusions and alarmist messaging

8.3 Evaluation from the perspective of citizens interested in good policymaking

- Public concerns about climate change are valid, as are concerns about cost of living, economic growth, employment, etc.
- We share the general concern that elected officials and those who serve them have the best information available when making important decisions around energy and climate policy
- NCA5 was a missed opportunity: it could have been a valuable input to that process but it did not turn out that way
- consequently its usage is unlikely to lead to better decisions and would more likely increase the error rate in policy formation and we recommend it not be used for policymaking purposes.

APPENDIXES

APPENDIX 1: Seth's letter on statutory requirements for NCA5

APPENDIX 2: Analysis of 141 U.S. Longterm Daily Precipitation Records.

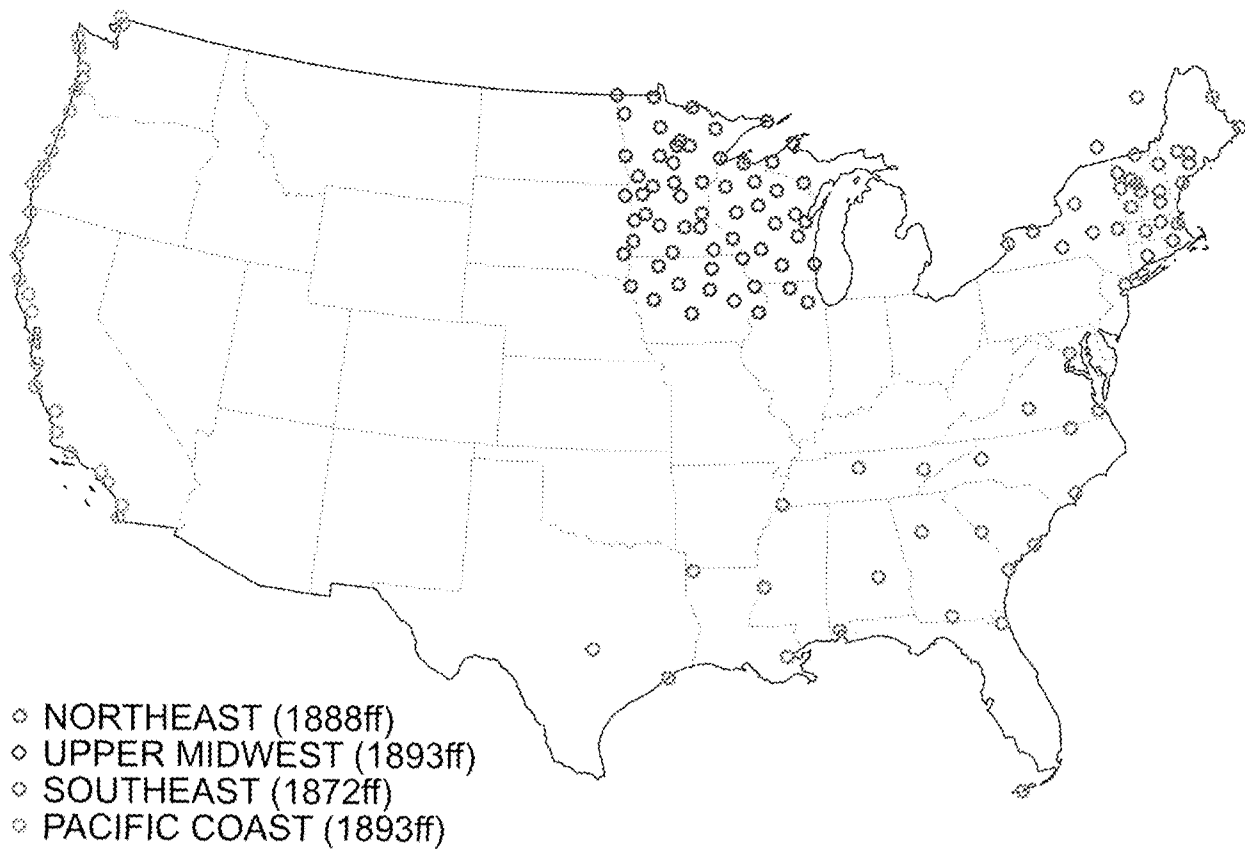


Figure. Stations used in the following analyses.

Table codes: (-) neg insignificant, -- neg significant, (+) pos insignificant, ++ pos significant.

Column 1: Measure

Column 2: Number of stations in that region

Column 3: Count of stations exhibiting a significant positive trend

Column 3: Count of stations exhibiting a significant negative trend

Column 5: Characteristic of region-wide trend

PACIFIC COAST

Since 1893:

	No. stns	+ trends	- trends	region
1-day average	29	0	1	(-)
2-day average	29	0	1	(-)
Avg on non-zero days	29	0	9	--
Variability	29	1	0	(+)
Annual max	29	2	1	(+)

Number of 99 th pct exceedances	29	1	0	(-)
--	----	---	---	-----

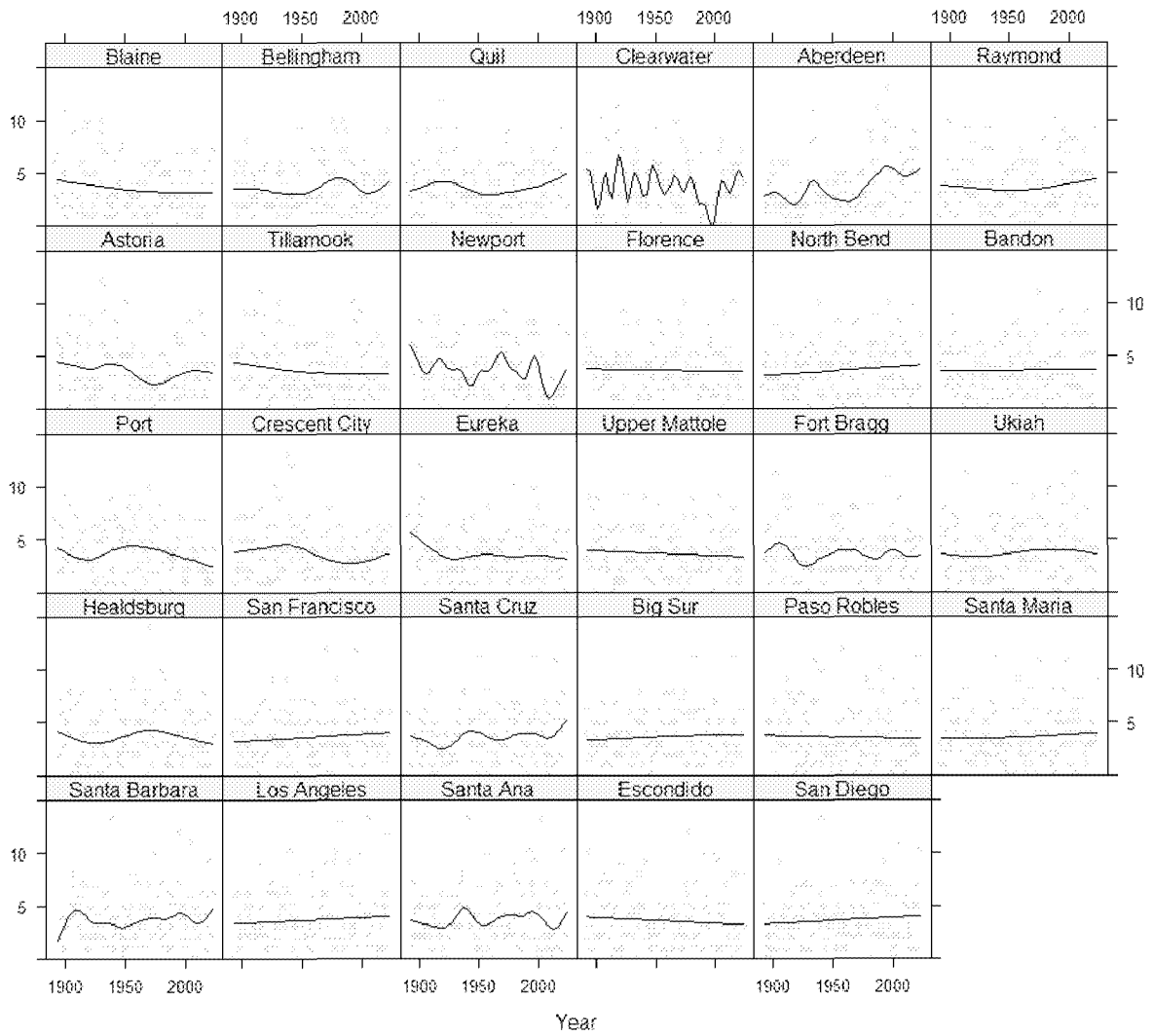
Since 1950:

	No. stns	+ trends	- trends	region
1-day average	29	0	1	(-)
2-day average	29	0	1	(-)
Avg on non-zero days	29	0	4	(-)
Variability	29	2	3	(-)
Annual max	29	6	3	(-)
Number of 99 th pct exceedances	29	2	1	(-)

Since 1980:

	No. stns	+ trends	- trends	region
1-day average	29	0	0	(-)
2-day average	29	0	0	(-)
Avg on non-zero days	29	0	1	(-)
Variability	29	0	0	(-)
Annual max	29	2	1	(-)
Number of 99 th pct exceedances	29	0	0	(+)

Annual No. 99th Percentile Exceedances PC 1893-2024



SOUTHEAST

Since 1873:

	No. stns	+ trends	- trends	region
1-day average	24	1	1	(+)
2-day average	24	1	1	(+)
Avg on non-zero days	24	7	2	(+)
Variability	24	1	0	(+)
Annual max	24	2	0	(+)
Number of 99 th pct exceedances	24	5	0	(+)

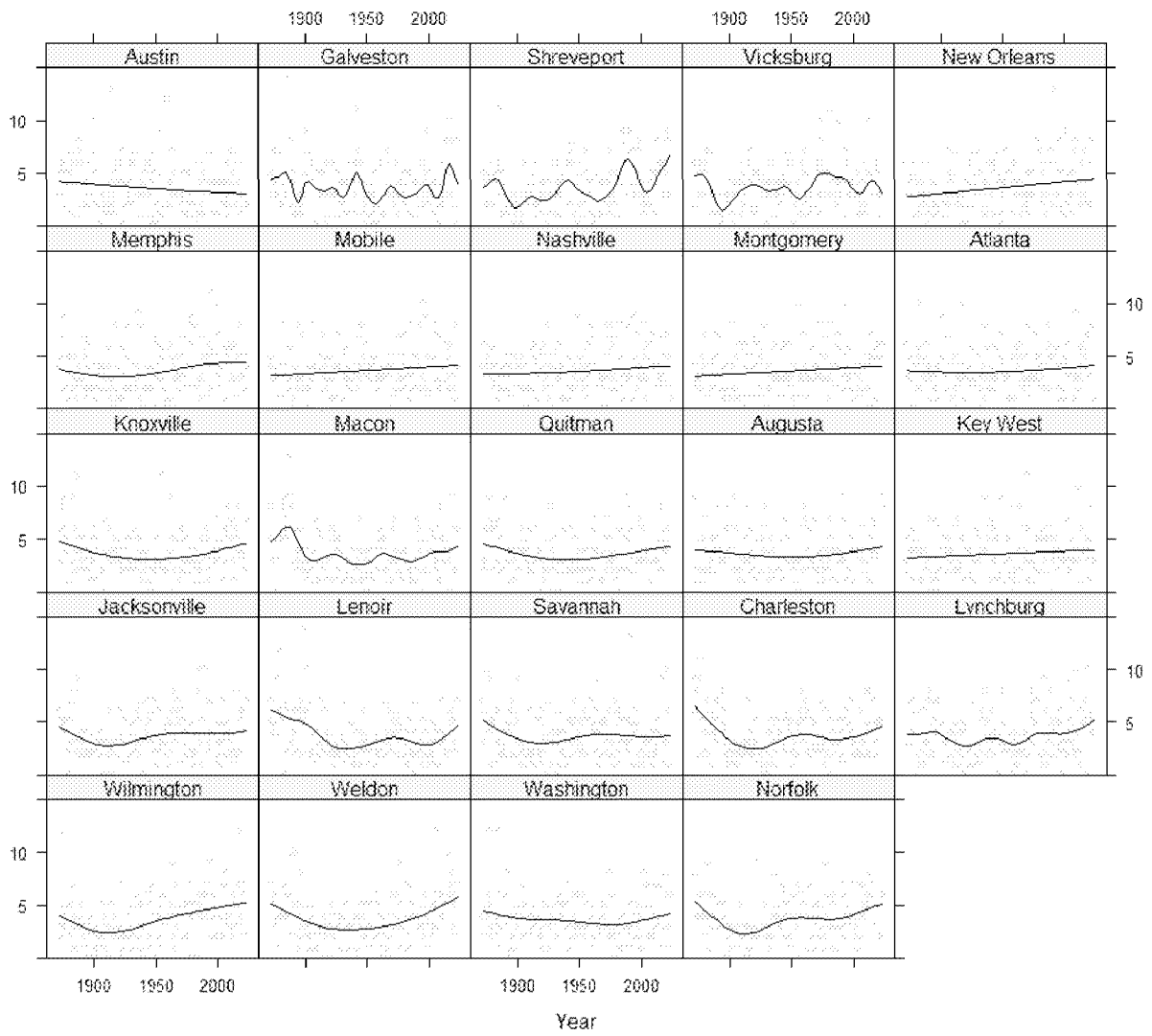
Since 1950:

	No. stns	+ trends	- trends	region
1-day average	24	5	0	++
2-day average	24	5	0	++
Avg on non-zero days	24	5	1	++
Variability	24	6	0	++
Annual max	24	4	0	++
Number of 99 th pct exceedances	24	4	0	(+)

Since 1980:

	No. stns	+ trends	- trends	region
1-day average	24	5	0	(+)
2-day average	24	5	0	(+)
Avg on non-zero days	24	5	1	(+)
Variability	24	3	0	(+)
Annual max	24	4	0	(+)
Number of 99 th pct exceedances	24	4	0	(+)

Annual No. 99th Percentile Exceedances SE 1873-2024



MIDWEST

Since 1893:

	No. stns	+ trends	- trends	region
1-day average	61	23	0	++
2-day average	61	23	0	++
Avg on non-zero days	61	2	12	(+)
Variability	61	12	0	++
Annual max	61	9	0	(+)
Number of 99 th pct exceedances	61	10	0	(+)

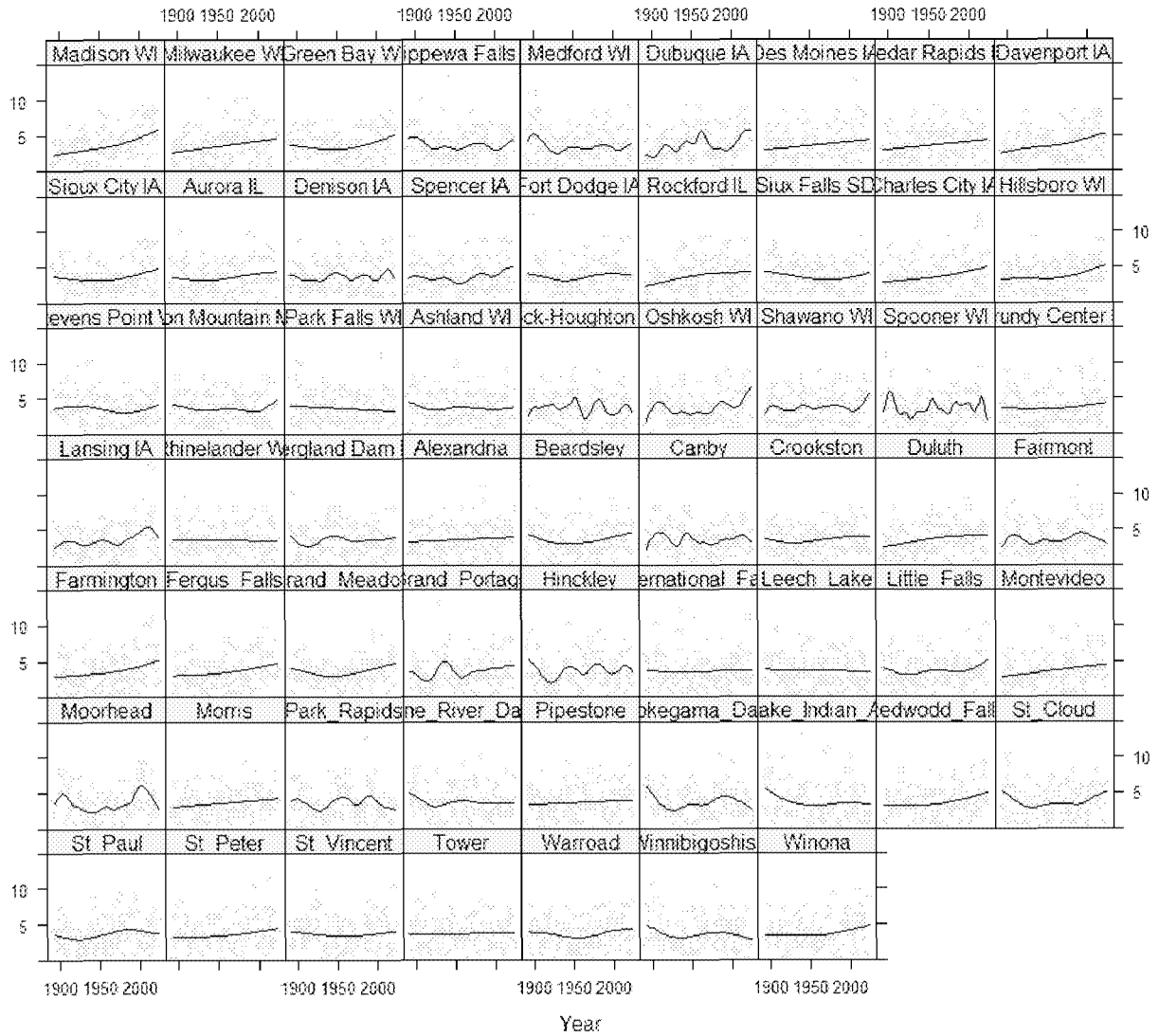
Since 1950:

	No. stns	+ trends	- trends	region
1-day average	61	28	2	++
2-day average	61	28	2	++
Avg on non-zero days	61	11	1	++
Variability	61	16	0	(+)
Annual max	61	8	0	(+)
Number of 99 th pct exceedances	61	19	0	++

Since 1980:

	No. stns	+ trends	- trends	region
1-day average	61	6	1	(+)
2-day average	61	6	1	(+)
Avg on non-zero days	61	8	2	(+)
Variability	61	5	1	(+)
Annual max	61	0	1	(+)
Number of 99 th pct exceedances	61	5	3	(-)

Annual No. 99th Percentile Exceedances MW 1893-2024



NORTHEAST

Since 1888:

	No. stns	+ trends	- trends	region
1-day average	27	12	0	++
2-day average	27	12	0	++
Avg on non-zero days	27	7	1	(+)
Variability	27	4	0	(+)
Annual max	27	3	0	(-)
Number of 99 th pct exceedances	27	5	0	(+)

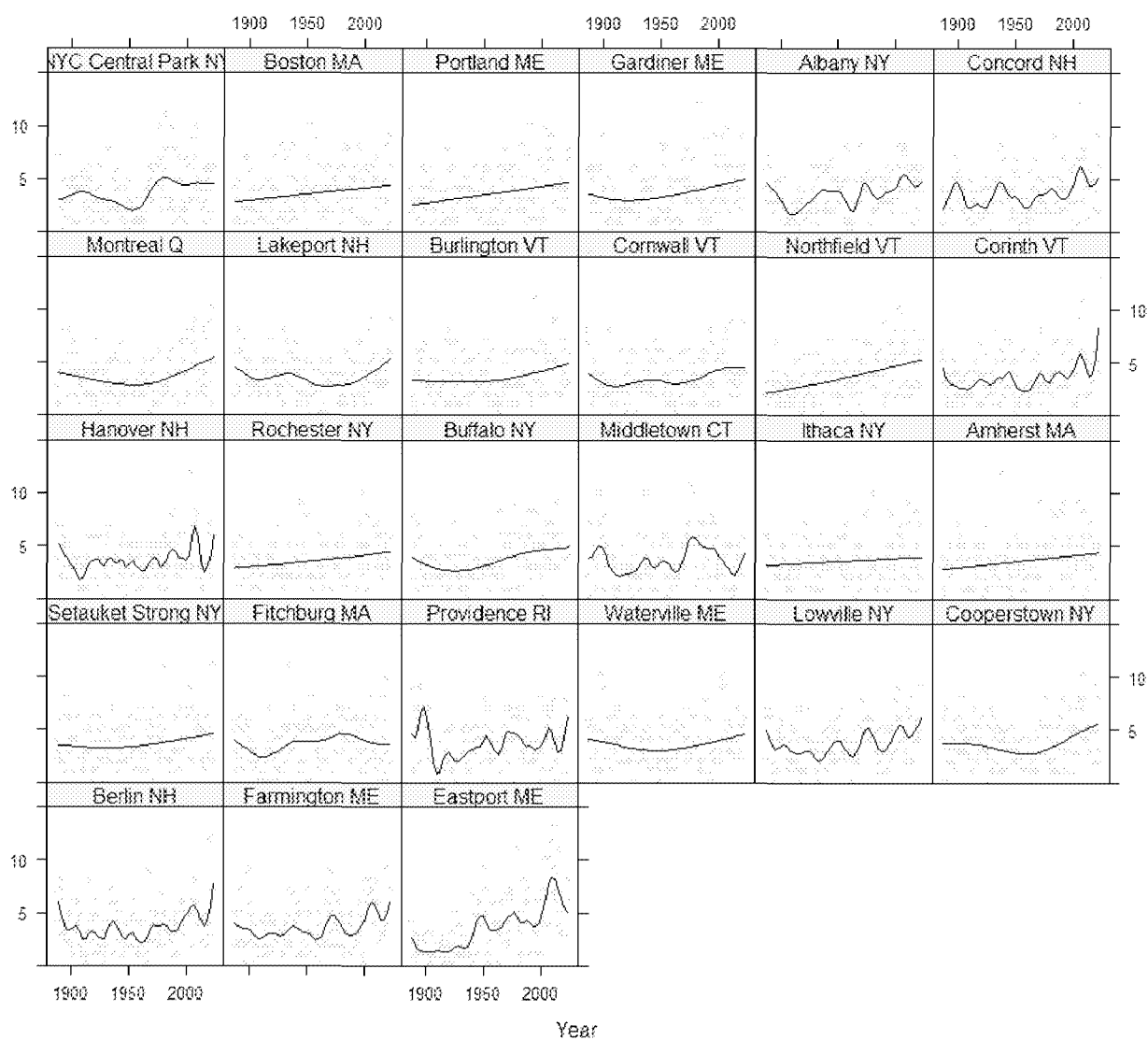
Since 1950:

	No. stns	+ trends	- trends	region
1-day average	27	12	0	++
2-day average	27	12	0	++
Avg on non-zero days	27	7	1	(+)
Variability	27	4	0	(+)
Annual max	27	3	0	(-)
Number of 99 th pct exceedances	27	5	0	++

Since 1980:

	No. stns	+ trends	- trends	region
1-day average	27	10	1	++
2-day average	27	10	1	++
Avg on non-zero days	27	6	0	(+)
Variability	27	2	0	(+)
Annual max	27	1	0	(+)
Number of 99 th pct exceedances	27	1	1	++

Annual No. 99th Percentile Exceedances NE 1888-2024



From: John Christy <climateman60@gmail.com>
Sent: Wednesday, June 11, 2025 10:14 PM
To: Steven Koonin
Cc: Judith Curry; Ross McKittrick; Roy W. Spencer
Subject: Re: something new in modeling?

Good for them. 45-day forecasts! So, they solved the turbulence problem that the likes of Heisenberg and Feynman couldn't.

John C.

Sent from my iPhone

On Jun 11, 2025, at 7:47 PM, Steven Koonin <steven.koonin@gmail.com> wrote:

Would sure like to see the validation

https://www.wsj.com/articles/nvidia-climate-in-a-bottle-opens-a-view-into-earths-future-what-will-we-do-with-it-f602d8de?st=8Ac8wN&reflink=desktopwebshare_permalink

From: Steven Koonin <steven.koonin@gmail.com>
Sent: Wednesday, June 11, 2025 8:48 PM
To: 'Judith Curry'; 'Ross McKittrick'
Cc: 'Roy W. Spencer'; 'John Christy'
Subject: something new in modeling?

Would sure like to see the validation

<https://www.wsj.com/articles/nvidia-climate-in-a-bottle-opens-a-view-into-earths-future-what-will-we-do-with-it-f602d8de?st=8Ac8wN&reflink=desktopwebshare> [permalink](#)

From: Ross McKittrick <ross.mckitrick@gmail.com>
Sent: Thursday, June 19, 2025 12:44 PM
To: Judith Curry
Cc: John Christy; Roy Spencer; Steven Koonin; Travis Fisher; Josh Loucks; Seth Cohen
Subject: Re: New ag article

The same team (Sol Hsiang, Tamma Carleton, Michael Greenstone etc) did a similar trick a few years ago when they published a paper reporting huge mortality costs from CO2. The headline-grabbing results in the body of the paper were based on RCP8.5 with no behavioral adaptation. You had to go to page 75 in the online Supplementary Information to find the results using RCP4.5 + adaptation: again the effects collapsed. I wrote an op-ed at the time showing that if they used the new Resources for the Future central emission scenario with adaptation they'd have concluded zero mortality effect.

On Thu, Jun 19, 2025 at 12:38 PM Ross McKittrick <ross.mckitrick@gmail.com> wrote:

Not exactly. The headline conclusions that got all the CNN coverage are based on RCP8.5 without CO2 fertilization. You have to dig into the details to find the sims under RCP8.5 with CO2 fertilization and RCP4.5 (to which they don't add CO2 fertilization). Either of these changes cause the losses to shrink considerably and become statistically insignificant. Had they used RCP4.5+CO2 they'd probably get net benefits. Also they use the CO2 fertilization effect from Moore et al 2017 which was not estimated empirically; it was just imposed as a heavily dampened growth function.

I saw the article yesterday when a colleague in Agric Econ sent it to me, fuming that such crap was being published.

Their treatment of adaptation seems to rely on income as a proxy for adaptive behaviour, but I haven't looked in further detail. They lost me at RCP8.5.

On Thu, Jun 19, 2025 at 12:25 PM Judith Curry <curry.judith@gmail.com> wrote:

This one accounts for adaptation and CO2 fertilization

<https://www.nature.com/articles/s41586-025-09085-w>



Judith Curry, President
CFAN - Climate Forecast Applications Network
Reno, NV USA
curry.judith@cfanclimate.com | +1.404.803.2012
<http://www.cfanclimate.net>

From: Ross McKittrick <ross.mckitrick@gmail.com>
Sent: Thursday, June 19, 2025 12:39 PM
To: Judith Curry
Cc: John Christy; Roy Spencer; Steven Koonin; Travis Fisher; Josh Loucks; Seth Cohen
Subject: Re: New ag article

Not exactly. The headline conclusions that got all the CNN coverage are based on RCP8.5 without CO2 fertilization. You have to dig into the details to find the sims under RCP8.5 with CO2 fertilization and RCP4.5 (to which they don't add CO2 fertilization). Either of these changes cause the losses to shrink considerably and become statistically insignificant. Had they used RCP4.5+CO2 they'd probably get net benefits. Also they use the CO2 fertilization effect from Moore et al 2017 which was not estimated empirically; it was just imposed as a heavily dampened growth function.

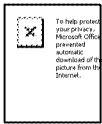
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curry.judith@cfanclimate.com | +1.404.803.2012
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From: Judith Curry <curry.judith@gmail.com>
Sent: Thursday, June 19, 2025 12:26 PM
To: John Christy
Cc: Roy Spencer; Ross McKittrick; Steven Koonin; Travis Fisher; Josh Loucks; Seth Cohen
Subject: New ag article

This one accounts for adaptation and CO2 fertilization

<https://www.nature.com/articles/s41586-025-09085-w>



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From: Ross McKittrick <ross.mckittrick@gmail.com>
Sent: Friday, August 15, 2025 11:00 AM
To: John Christy
Cc: Steven Koonin; Judith Curry; Roy Spencer
Subject: Re: NCA5

Ah. I can see why people are getting worked up. What he said was "updated reports ON those and with comments ON those." I suspect many people heard "updated reports" and stopped listening at that point. We do need to get back to the NCA5 report when we can, once we have guidance from the suits about what we're able or not able to discuss.

On Fri, Aug 15, 2025 at 10:52 AM John Christy <climateman60@gmail.com> wrote:
From The Hill

Energy Secretary Chris Wright indicated this week that the Trump administration is reviewing and could seek to change past climate reports.

Wright, in a Tuesday evening appearance on CNN's "The Source," was asked why the administration removed past versions of the National Climate Assessment from government websites.

"Because we're reviewing them," he replied, "and we will come out with updated reports on those and with comments on those."

When reached for comment, the Energy Department declined to provide more information on the review efforts. Instead, spokesperson Andrea Woods referred The Hill to remarks from Wright during the same interview.

"I don't know why they're taken down," Wright told host Kaitlan Collins. "They're easy to find anywhere. If anybody can't find the National Climate Assessment report, they just got to Google a little better."

Woods told CNN that Wright "was not suggesting he personally would be altering past reports."

The 1990 Global Change Research Act requires the federal government to produce a report about climate change every four years.

Sign up for the Morning Report

On Fri, Aug 15, 2025 at 9:49 AM Steven Koonin <steven.koonin@gmail.com> wrote:
(Note dropping Jeremy from the cc list)

I think we should find some way to release our critique of NCA5, taking care to purge it of any recommendations. Could be an Appendix to the CWG final, since it's likely that more than a few comments will refer to it.

Steven E. Koonin

On Aug 15, 2025, at 07:43, John Christy <climateman60@gmail.com> wrote:

These were the Secretary's remarks about revisiting the NCA5. They were fairly vague.

John C.

On Fri, Aug 15, 2025 at 9:42 AM Ross McKittrick <ross.mckittrick@gmail.com> wrote:

John can you ask them for details or sources of this news? I for one know nothing about any plans to create a revised version of NCA5.

On Fri, Aug 15, 2025 at 10:40 AM John Christy <climateman60@gmail.com> wrote:

As mentioned earlier, several folks on the State Climatologist listserve, who helped author NCA5, are consternating over a proposed modification of NCA5. As I understand it, we will offer a review of NCA5 but with legal issues now, are we being asked to make any recommendations? Will our review even be released (when we finalize it)?

John C.

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Cc: Ross McKittrick; Judith Curry; Roy Spencer
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Sent: Friday, August 15, 2025 10:49 AM
To: John Christy
Cc: Ross McKittrick; Judith Curry; Roy Spencer
Subject: Re: NCA5

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Sent: Friday, August 15, 2025 10:44 AM
To: Ross McKittrick
Cc: Judith Curry; Roy Spencer; Steve Koonin; Jeremy T. Ison
Subject: Re: NCA5

These were the Secretary's remarks about revisiting the NCA5. They were fairly vague.

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I vaguely remember being asked to contribute just two back-up examples of the NCA5 failures. It appears some are looking at 3, so attached is my third contribution about snowfall in the West. It is less potent than the other two, so may not make the cut.

Before you say this piece looks rather self-serving, I'll just say no one else put such sweat-equity into dredging up tens of thousands of snowfall records from the 19th century to build these long-term datasets so we can answer questions about long-term snowfall trends. Fortunately, as a super nerd who grew up in the shadow of the Sierras and has been passionate about western weather since hitting double digits, it was a labor of love.

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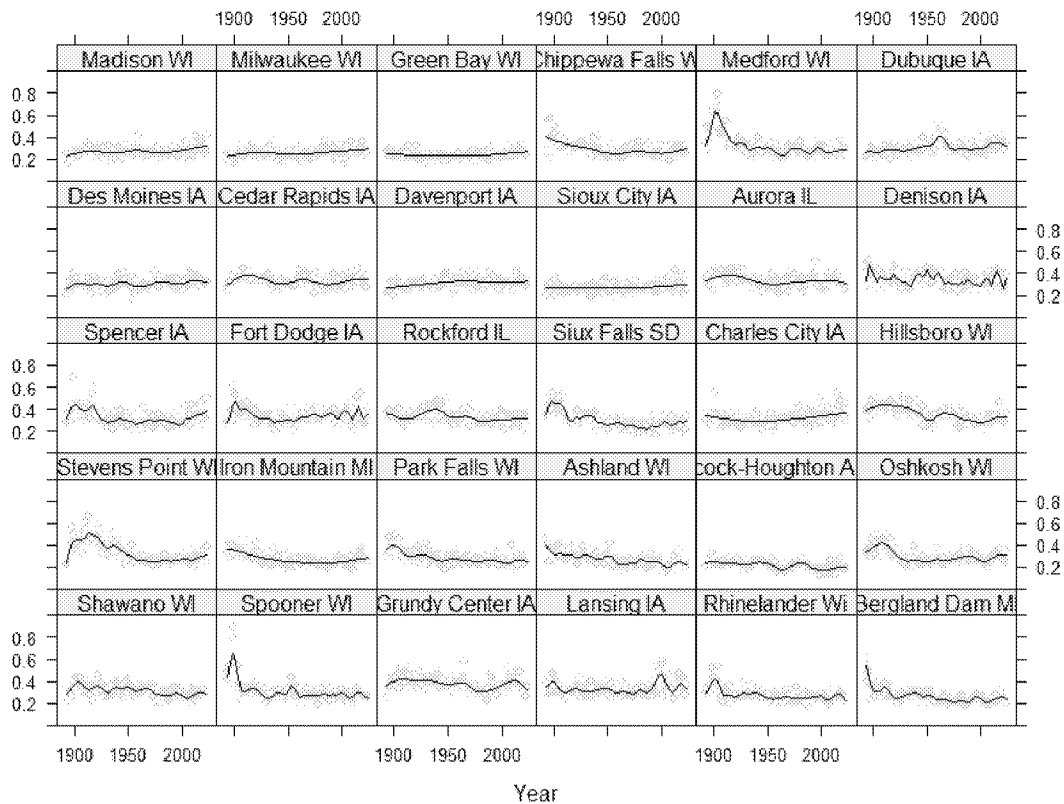
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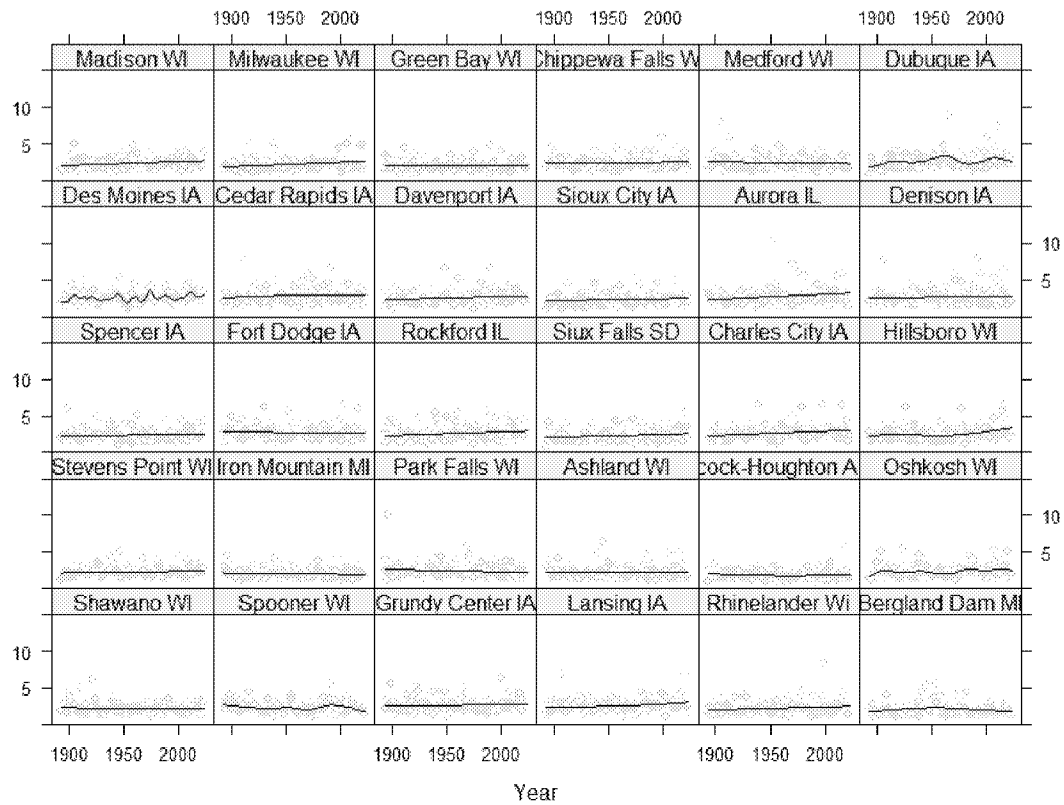
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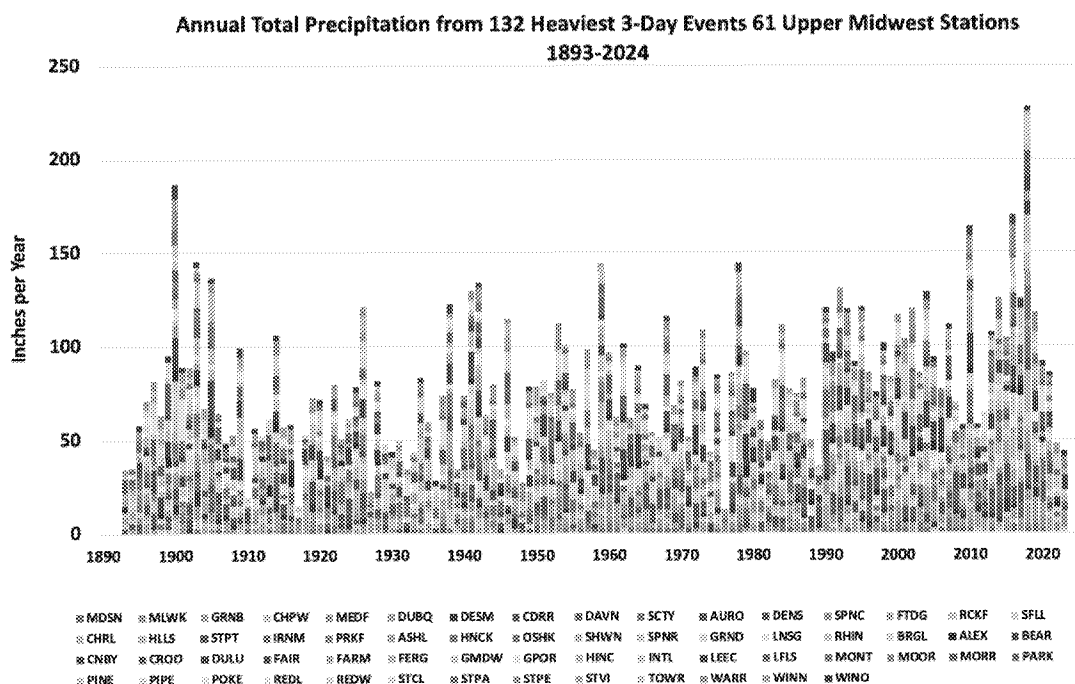
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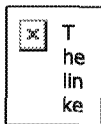
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The introduction to NCA5 Chapter 4 “Water” is unequivocal and rather ominous.

Climate change is intensifying rainfall and floods, deepening droughts, and shifting weather patterns across the globe, causing profound effects on terrestrial freshwater supplies and quality. Rising sea levels, reduced snowpacks, shrinking rivers, and declining groundwater threaten cities and rural communities and endanger forest, riverine, and other ecosystems across the United States.

The CWG25 report provides evidence that several of these alarming claims are misleading or untrue. Here we examine “Box 4.1 Washington-California 2015 Snow Drought” in which a single season was examined for its record or near-record low snow totals to draw attention to a drying climate in the West. While the Introduction shouts about “*deepening droughts and shifting weather patterns*” in the later text under “Drought Impacts” the NCA5 acknowledges that “*Megadroughts are events of extraordinary duration and severity, and many are documented in paleoclimate records.*” However, this is then followed by more somber statements,

Temperature’s contribution to drought makes it clear that warming associated with climate change could increase the frequency, severity, and/or duration of drought and drive aridification, a long-term shift toward a drier climate, which is a concern in already dry parts of the West.

and

In areas of the West where snow is the dominant source of runoff, total seasonal snow water volume is projected to decrease by more than 24% by 2050 under intermediate (RCP4.5) and higher scenarios, with persistent low-snow conditions emerging within the next 60 years.

Thus, on the one hand, major shifts in historical precipitation (and thus snowfall) patterns in the West are well documented in which “megadroughts” - more significant than any dry spell of the past 130 years - are a normal part of the western climate system. On the other hand, the NCA5 informs us that we should be concerned about these patterns as they “shift toward a drier climate”.

“Snowfall” is the total of the amount of snow that falls each day accumulated over a season. This is not the more familiar “snowpack on 1 April” which is simply the depth of snow on a single day which represents the snow that has accumulated through the winter but not yet melted. This latter metric is operationally useful for hydrologic projections of spring and summer runoff in the far-western mountains (Cascades in Washington and Oregon and Sierra Nevada in California).

[Snowfall is actually a directly-measured metric as opposed to “water equivalent”, the amount of liquid the snow would produce if melted. Before 1960, water equivalent was often not measured at all but simply (and easily) calculated as the new snowfall divided by 10 (examples in Christy 2012).]

Has western snowfall changed as a result of “a long-term shift toward a drier climate”? As noted above, NCA5 cites a modeling study that projects a 24% decline in snowfall by 2050, though total precipitation projections are mixed, being positive for the Cascades and negative for the Sierra Nevada (NCA5 Fig. 4.3).

Christy 2022 examined the snowfall question for the western mountain ranges of the Cascades and Sierra Nevada. Updated information through the 2024-25 season is presented below. Trends since the late 19th century and since 1975 (last 51 years) are insignificant due in part to the high interannual variability, thus an attributable decline has not been detected. The evidence provided here does not suggest a long-term shift toward decreasing snowfall in the mountains of the Pacific West (see also CWG25 6.4).

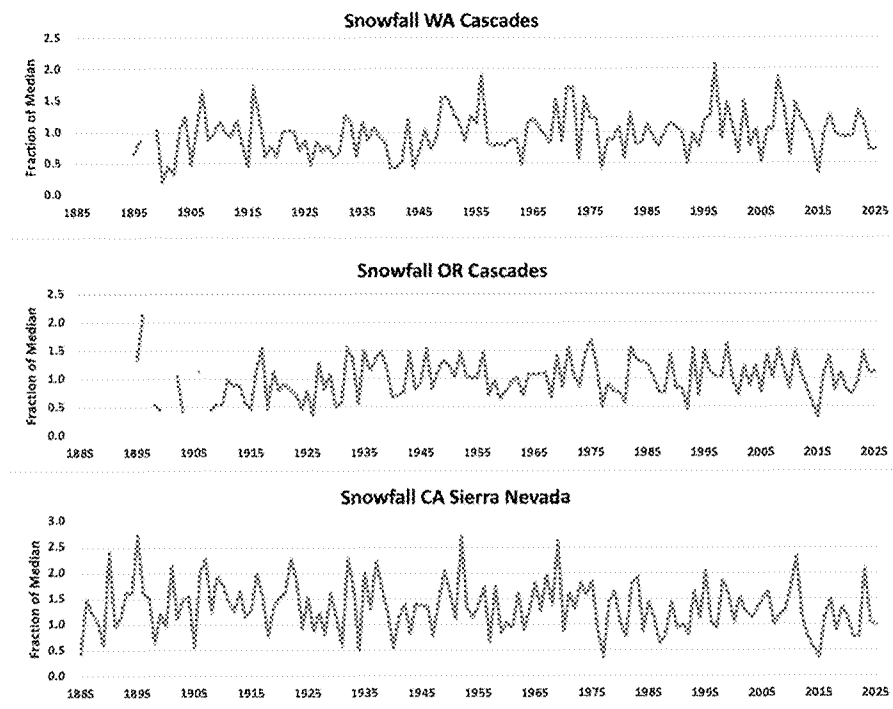


Figure. Nov-Apr snowfall as a fraction of the seasonal median total for the Cascades of Washington (top) and Oregon (center) and the Sierra Nevada of California (bottom).

Christy, J.R., 2012: Searching for information in 133 years of California snowfall observations. *J. Hydrometeor.* 13, 895-912. DOI:10.1175/JHC-D-11-040.1.

Christy, J.R., 2022: Time series construction of Oregon and Washington snowfall since 1890 and an update of California snowfall through 2020. *J. Hydrometeor.* DOI:10.1175/JHM-D-21-0178.1.

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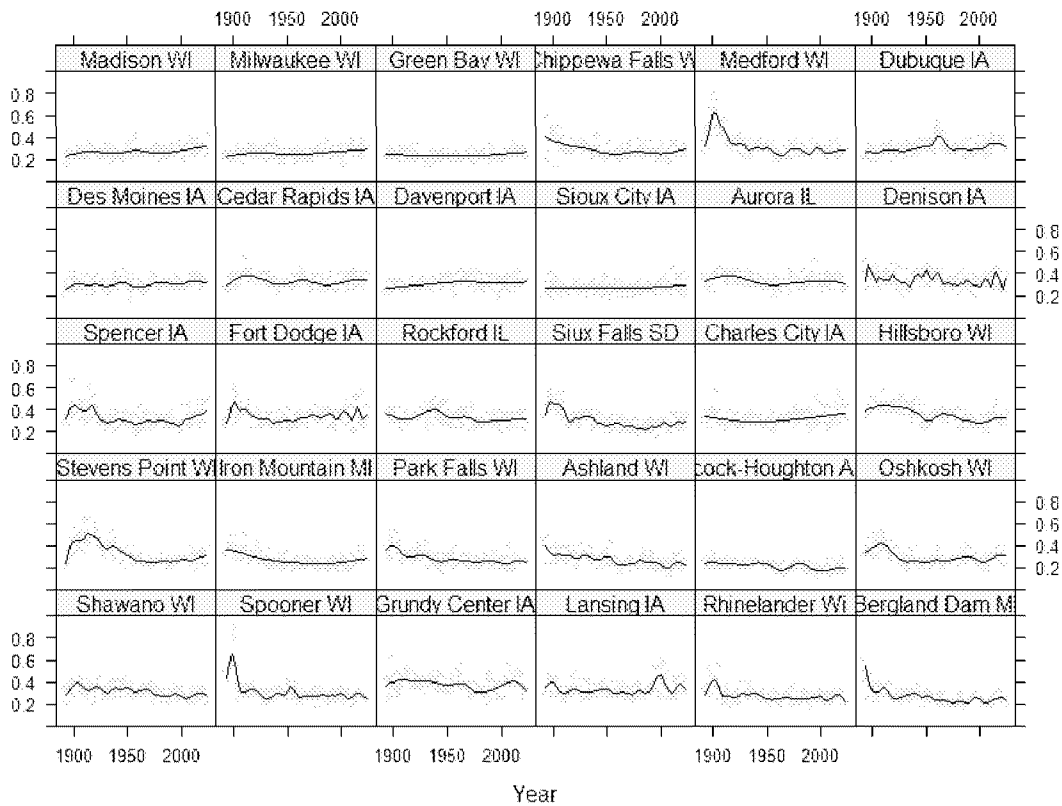
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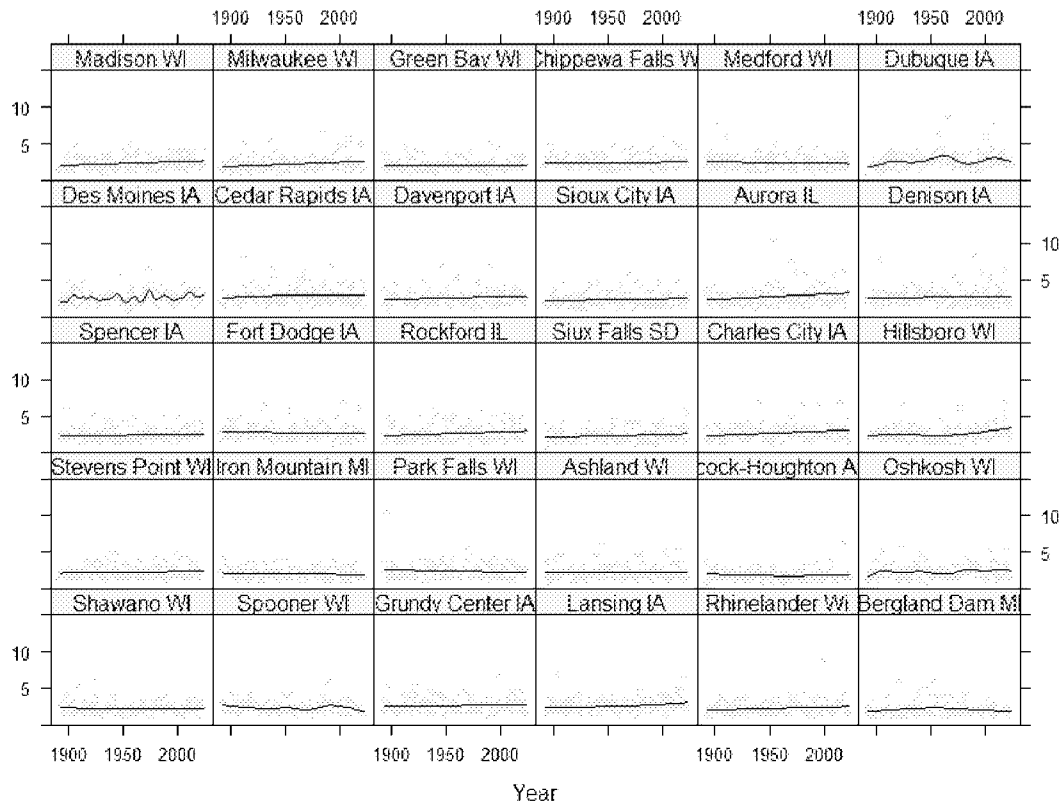
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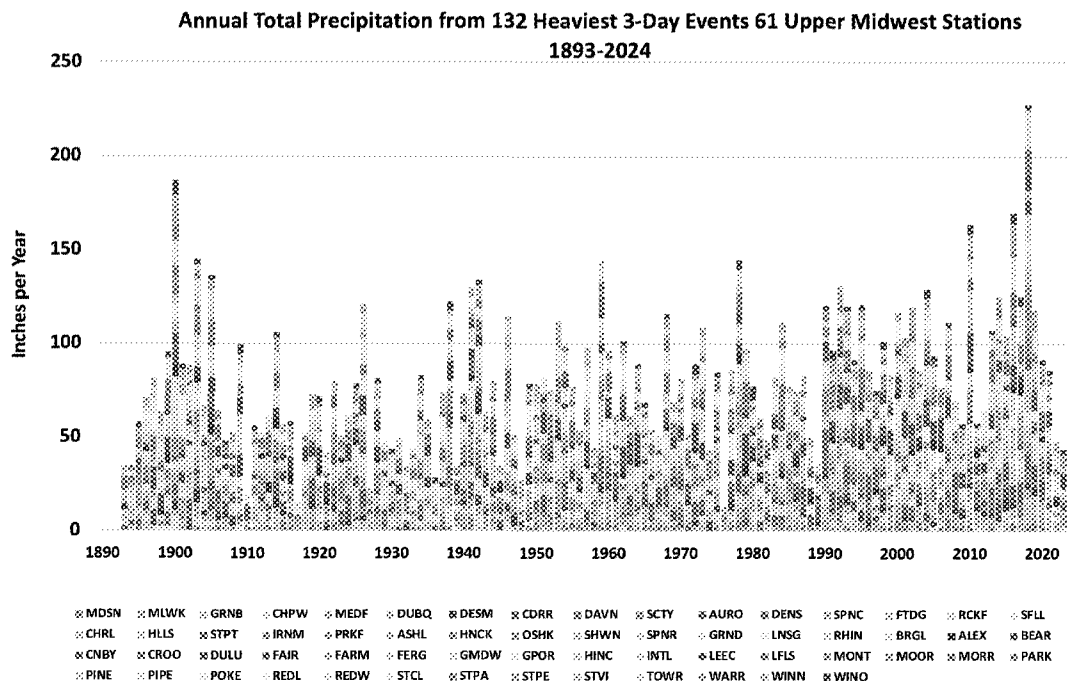
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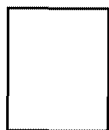
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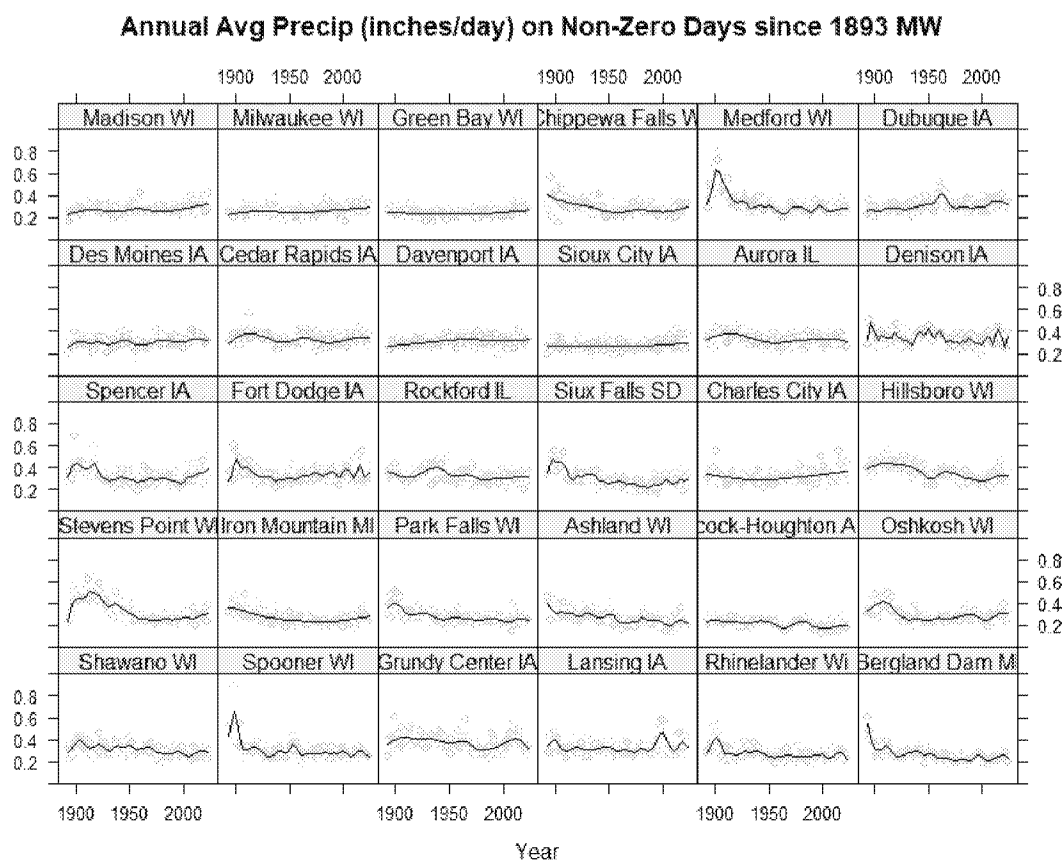
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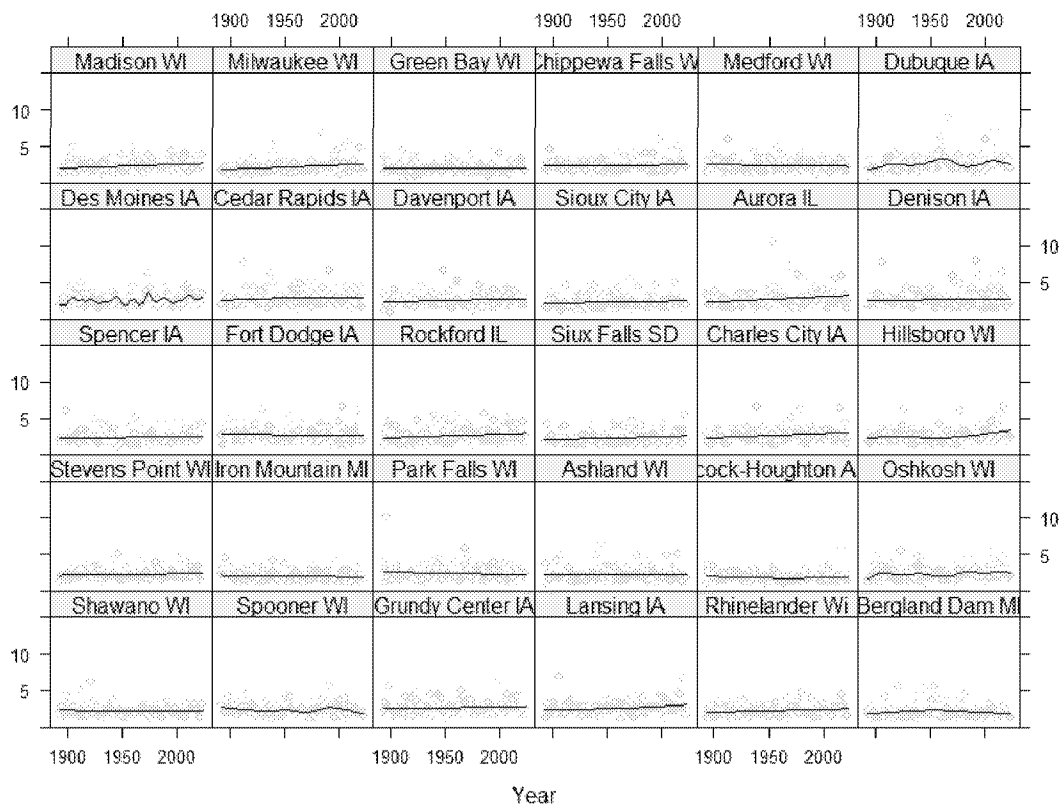
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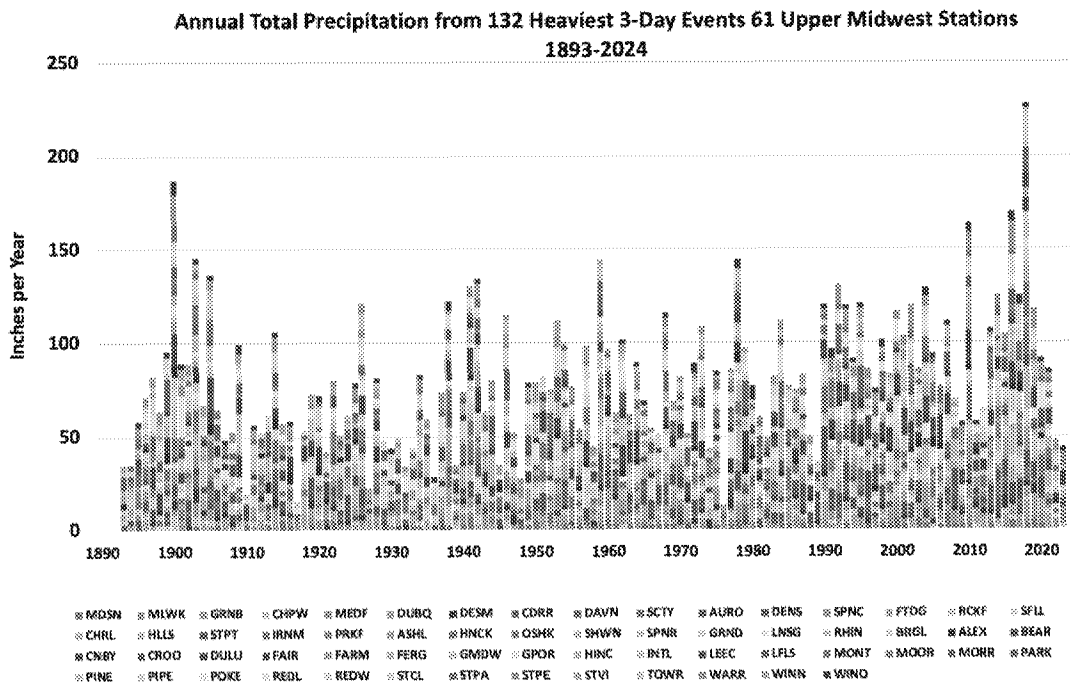
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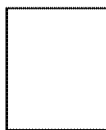
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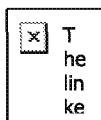
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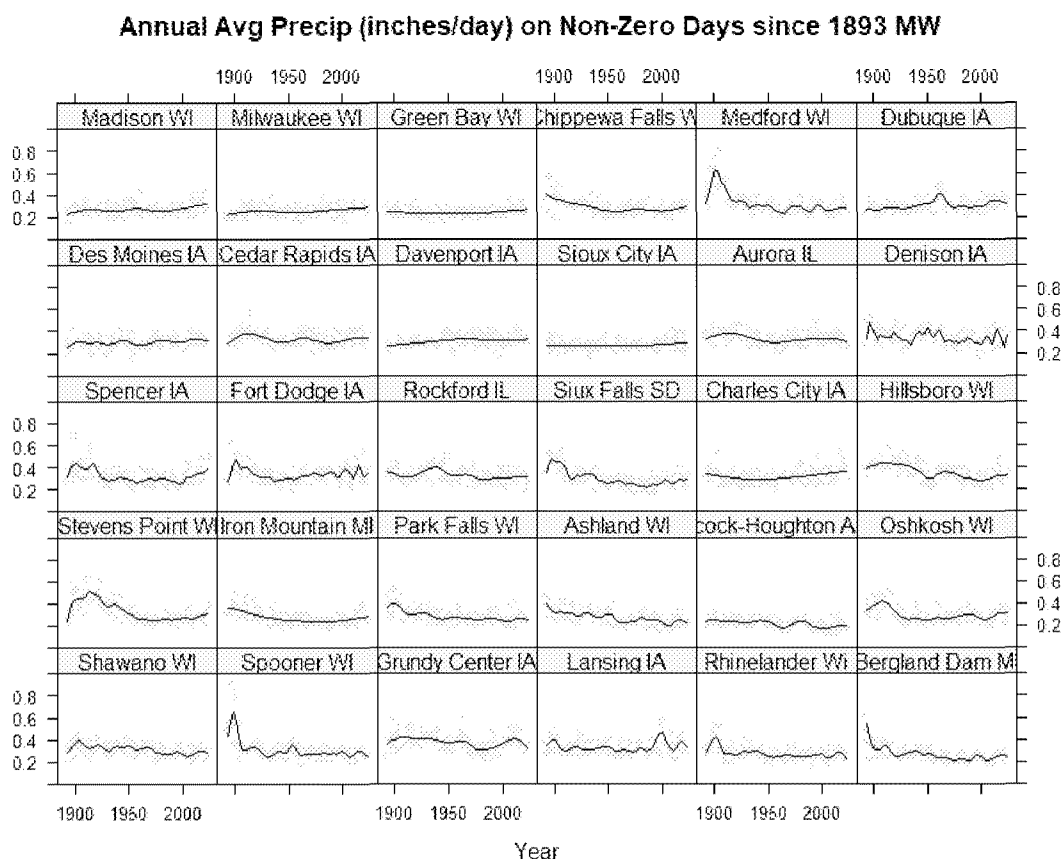
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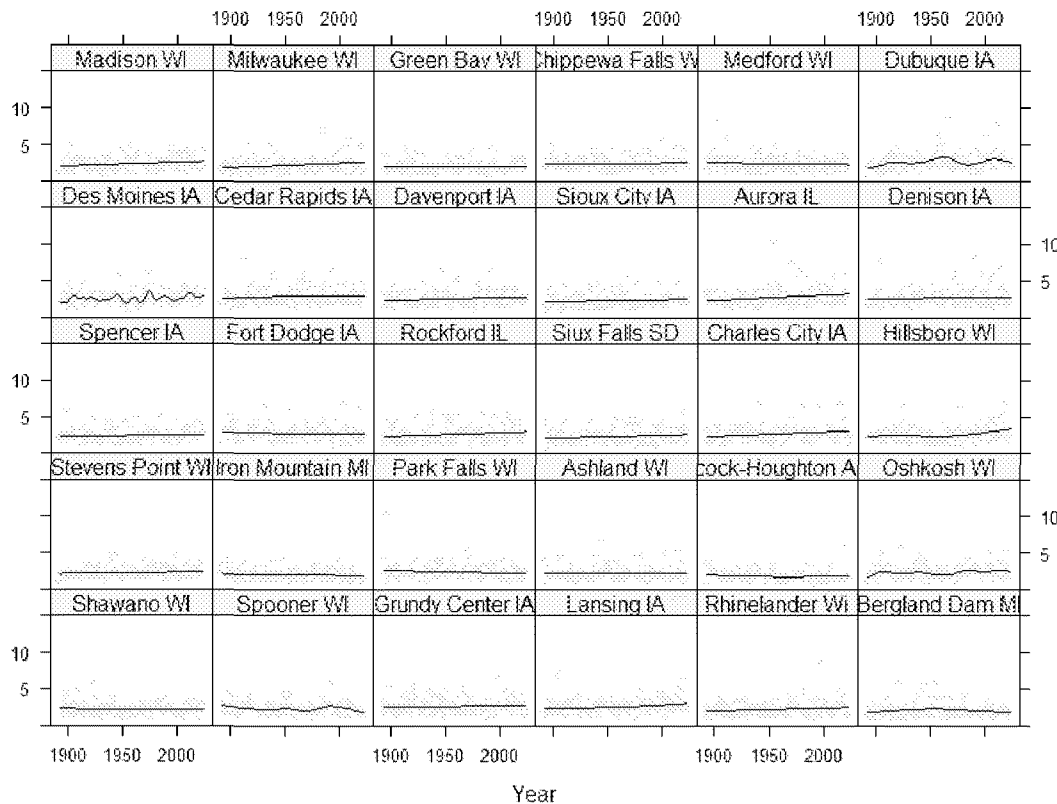
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Annual Max Precipitation (inches/day)



Regarding annual averages: 15/30 have a + and significant trend and the regional average trend is + and significant.

Regarding annual Max: 5/30 are + and significant and the regional average is + and insignificant.

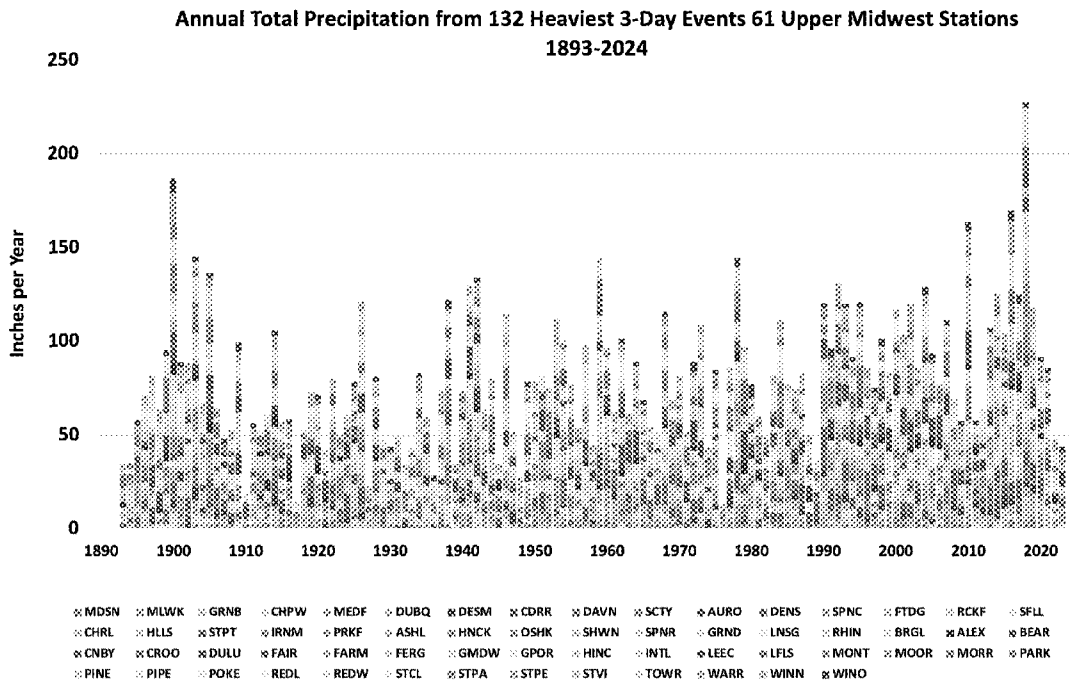
Heading into a meeting, more later..

Ross

On Thu, Jun 5, 2025 at 2:26 PM John Christy <climateman60@gmail.com> wrote:
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To: John Christy <climateman60@gmail.com>

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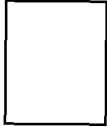
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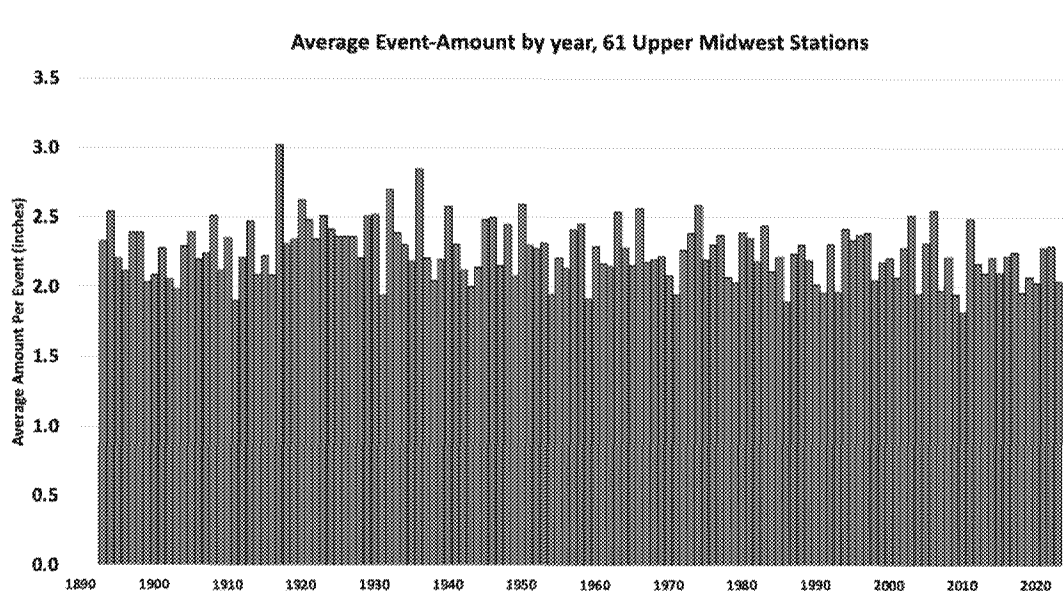
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Subject: Re: 3 thematic items
Attachments: ~WRD0004.jpg; 3dy_132events_UpMidWest.png; 3dy_AvgEvent_UpMidWest.png

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I thought about the damage to infrastructure from extreme 3-day events and did this calculation - the average amount falling in those heaviest events by year. What this says is that the events aren't getting heavier, but that since 1990 there have been more of them (see previous email). That would imply to me if you are able to accommodate heavy events now, you should in the future given their once-per-year average frequency and lack of increasing magnitudes.

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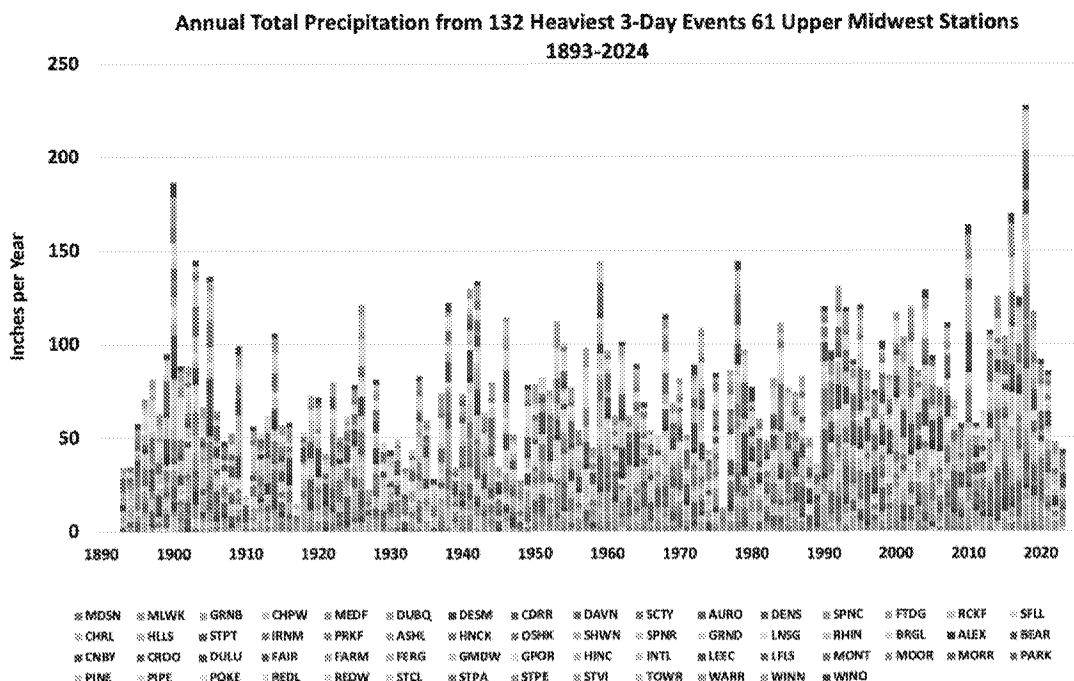


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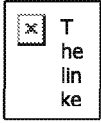
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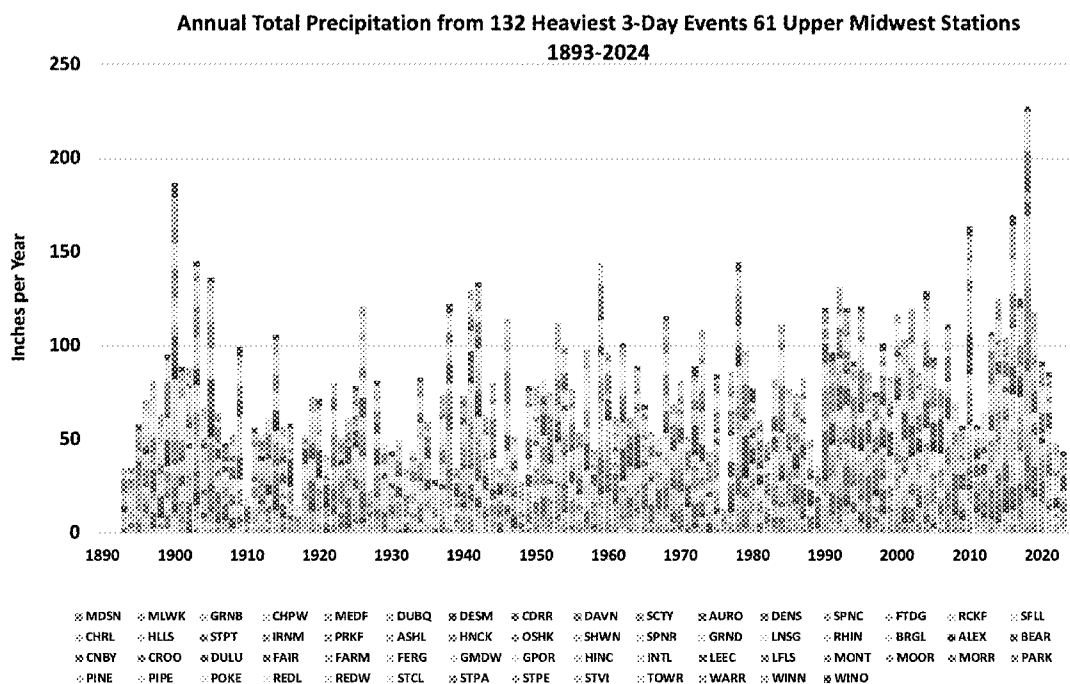
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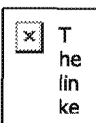
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Cc: Ross McKittrick; Travis Fisher; Josh Loucks; Roy W. Spencer; Steven Koonin
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I think we do need to deal with NCA4 to some extent

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In my precip snapshot I also addressed the two precipitation citations on 2-18 (Diffenbaugh et al. 2018 and Kirchmeier-Young and Zhang 2020) but noting two very different deficiencies - they used short periods for their "historical" record and both used RCP8.5 model output.

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On NCA4 ES.5, Unsettled has a whole chapter on that, which could be adapted for text. Perhaps it could be worked in by showing the deficiencies of the NASEM review process – NASEM had flagged a problem, USGCRP then responded with the figure, which was even more flawed, but never reviewed by NASEM.

I'll see if I can work it into the draft that way.

SEK

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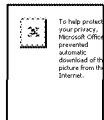
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Pervasive advocacy language and framing:
Overstating what underlying sources show
and
Uncritical definition of scientific "advance"

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<http://www.cfanclimate.net>

From: John Christy <climateman60@gmail.com>
Sent: Thursday, June 5, 2025 10:45 AM
To: Ross McKittrick
Cc: Travis Fisher; Josh Loucks; Roy W. Spencer; Judith Curry; Steven Koonin
Subject: Re: 3 thematic items

Ross

In my precip snapshot I also addressed the two precipitation citations on 2-18 (Differbaugh et al. 2018 and Kirchmeier-Young and Zhang 2020) but noting two very different deficiencies - they used short periods for their "historical" record and both used RCP8.5 model output.

Steve

I'm wondering if there is still a way to bring up the egregious and prominent NCA4 Figure ES.5 where a deception was performed by claiming "Record Warm Daily Temperatures are Occurring more often" when in fact the opposite was the case? Judy points out NCA4 carried out a look at climate science, but this is one example that in that feeble attempt it was woefully inadequate. Then, the NCA5 did not perform any self-correcting exercise on previous mistakes (NCA4 ES.5) which is how science actually advances (also gets to Ross's point about overstating "advances").

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Sent: Thursday, June 5, 2025 9:18 AM
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Subject: Re: 3 thematic items

The topics I'm working on are
Hurricanes (this is a good one)
Sea level
RCP8,.5 (not as simple as it seems, they rely alot on critical warming levels)

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Pervasive advocacy language and framing:

Ch1 - overview

- Overview presents neither balanced assessment nor explanation of uncertainties.
- Page 1-6 policy advocacy that fails to discuss costs of actions
- “Each additional increment of warming leads to greater risks” but so does each additional increment of measures to reduce GHG emissions
- P. 1-9 uses irrelevant cost measure (“levelized”)
- 1-14 includes SSP5-8.5 in list of “plausible futures”
- 1-16 Changes are unprecedented over thousands of years: yet measurement of pace of change thousands of years ago are very imprecise
- 1-16 refers to trends without reference to the time scale
- 1-17 all statements presented as definitive with no admission of uncertainty or contingency on data quality and estimation methods
- 1-18 uses BDD data set which has been withdrawn
- 1-19 LST versus median household income within cities has nothing to do with climate. It’s a feature of urban planning
- 1-26 projected losses due to flooding ignores current data showing decreasing floods on average <https://www.epa.gov/climate-indicators/climate-change-indicators-river-flooding>
- 1-42 makes very non-mainstream assertion about climate economics

Ch 2

Key message 2.1 “Climate Is Changing, and Scientists Understand Why”

- Overly confident language
- 2-4 US warming faster than planet as a whole. But this is trivial since the comparison includes oceans. All land surfaces warm faster than the ocean. So why raise this point?
- PNW heat wave used as an example of validity of extreme event attribution – we address this work in CWG25 report. NCA5 hedges a bit by only saying AGW raised the temperature a couple of degrees. But then:
 - Para 3: CC affecting people, Extreme heat resp for more than 700 deaths per year from 2004 to 2018. But doesn’t mention decline in cold weather-related mortality. Then invokes BDD without acknowledging limitations
 - Para 5: Climate change has other consequences... the PNW heat wave caused more than 1400 heat-related deaths (thus insinuating all deaths due to AGW rather than tiny fraction associated with final degree of warming)
- Western wildfires “made more severe by climate change” yet intensity trends don’t support this (CWG Fig 6.8.3) also global data don’t support this claim

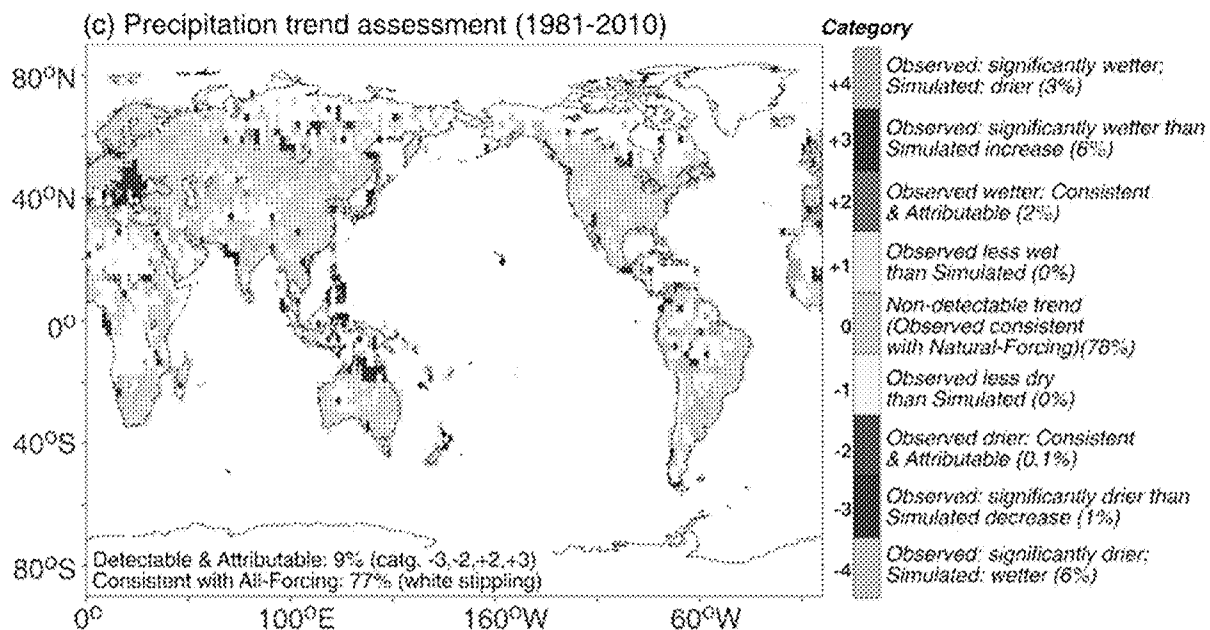
Reliance on Billion Dollar Disaster data in multiple places. Even if it hadn’t recently been officially withdrawn the authors should have assessed it skeptically and rejected it as unfit for the purpose of measuring climate trends.

Overstating what underlying sources show

P. 2-11 increase in precipitation in central and eastern US based on comparison of 2002-2021 average to 1901-1960, which is a weird metric, the change is called a “trend” although that’s not how a trend is measured, and it is “attributable to climate change”. The claims were attributed to

- Knutson and Zeng (2018) “Model Assessment of Observed Precipitation Trends over Land Regions: Detectable Human Influences and Possible Low Bias in Model Trends” *Journal of Climate* 31(12) <https://journals.ametsoc.org/view/journals/clim/31/12/jcli-d-17-0672.1.xml>

But it did not say these things. It examines linear trends over 1901 – 2010, 1951 – 2010 and 1981 – 2010. It does not compare average rainfall over 2002 – 2021 to average rainfall over 1901 – 1960. With regard to the final period its results are:



Gray indicates no trends detected. Stippling means only that there were no trends in the models either so the models and obs agreed in that respect. Detectable and attributable trends occur over only 9% of the land surface of the Earth. Over the US there are detectable trends over only a few regions in the SW.

p. 2-18: “There is robust evidence that human-caused warming has contributed to increases in the frequency and severity of the heaviest precipitation events across nearly 70% of the US.”

Attributed to two papers:

Diffenbaugh, N.S., D. Singh, and J.S. Mankin, 2018: Unprecedented climate events: Historical changes, aspirational targets, and national commitments. *Science Advances*, 4 (2), 3354. <https://doi.org/10.1126/sciadv.aao3354>

And

Kirchmeier-Young, M.C. and X. Zhang, 2020: Human influence has intensified extreme precipitation in North America. *Proceedings of the National Academy of Sciences of the United States of America*, **117** (24), 13308-13313. <https://doi.org/10.1073/pnas.1921628117>

Diffenbaugh et al. present ratios of occurrences of extreme events to natural-only simulations from CMIP6 models. They report that for 79% of the U.S. extreme rainfall events are currently greater than frequencies in the models, and the ratio of occurrences will rise under future warming simulations. This is not “robust” evidence of anthropogenic influence, it only shows a discrepancy between models and observations which the authors interpret as evidence of anthropogenic forcing, on the assumption that the discrepancies would disappear if anthropogenic forcing were introduced. However they present no confirmation of that claim.

Kirchmeier-Young and Zhang looked at extreme 1- and 5-day events in North America and, using 3 GCMs, found “A signal of combined anthropogenic and natural external forcing can be detected in the intensification of extreme precipitation at the continental scale over North America. In some cases, this intensification can be attributed to human influence specifically.” However they noted large differences among the three models in their simulated precipitation changes. Also, 2 of the 3 models failed to yield detection for Rx5Day for the NA mean. Finally the authors used TLS, a biased estimation method. Here again this is not “robust” evidence, it is suggestive but other studies have found natural variability predominant.

- 2-19 drought risk. Again a weird trend metric: Colorado River streamflow over 2000-2014 was 19% lower than the 20th century average. Droughts lasting longer and this is not temporary it is a drier “new normal”. This is attributed to

Overpeck, J.T. and B. Udall, 2020: Climate change and the aridification of North America. *Proceedings of the National Academy of Sciences of the United States of America*, **117** (22), 11856-11858. <https://doi.org/10.1073/pnas.2006323117>

But this article is only a commentary and does not present any new research. It notes some changes and discusses in qualitative terms that they might be indicators of what’s to come in the future.

p. 3-10 Narrowing range of ECS by 50%.

This section summarizes the issue with way too much confidence.

NCA5 says the narrowing has been achieved “through unprecedented quantitative synthesis of evidence from observed changes over recent decades, the industrial era, and paleoclimate.” It was one study, and it has already received substantial challenge in the literature (CWG 4.3)

The NCA5 section provides no discussion of the simultaneous emergence of evidence (especially from the LT and MT) of low ECS.

Uncritical definition of scientific “advance”

p. 3-13ff “New Data and Analysis Methods Have Advanced Climate Science”

This section treats development of new scenarios as a scientific “advance” without addressing the failure of previous scenarios to match reality or the likelihood that the new ones fail in the same regard. It also reports availability of large model ensembles as an advance, without addressing ways in which models are getting worse in some key respects. It also equates the increased use of rapid Extreme Event Attribution as an advance, without assessing whether the technique is valid in the first place.

Emergent constraints likewise discussed in completely uncritical terms:

An approach to reduce uncertainty in climate change projections has matured over the past decade. It is known as “emergent constraints.” The term refers to strong statistical relationships between highly uncertain future climate parameters and observable trends or variations in the current climate, along with a physical explanation of this relationship.

They fail to discuss any studies showing Emergent Constraints patterned on CMIP5 models failed to work on CMIP6 models, E.g.

- Manuel Schlund, Axel Lauer, Pierre Gentine, Steven C. Sherwood, and Veronika Eyring (2020) Emergent constraints on equilibrium climate sensitivity in CMIP5: do they hold for CMIP6? *Earth System Dynamics* 11 1233-1258 <https://doi.org/10.5194/esd-11-1233-2020>

Shows that emergent constraint relationships derived for CMIP5 models fail badly in CMIP6 models:

In this study, we systematically analyze 11 published emergent constraints on ECS that have mostly been derived from models participating in the Coupled Model Intercomparison Project Phase 5 (CMIP5) project... The focus of the study is on testing if these emergent constraints hold for ESMs participating in the new Phase 6 (CMIP6). Since none of the emergent constraints considered here have been derived using the CMIP6 ensemble, CMIP6 can be used for cross-checking of the emergent constraints on a new model ensemble. **The application of the emergent constraints to CMIP6 data shows a decrease in skill and statistical significance of the emergent relationship for nearly all constraints, with this decrease being large in many cases.** Consequently, the size of the constrained ECS ranges (66% confidence intervals) widens by 51% on average in CMIP6 compared to CMIP5.

Yet the introduction of emergent constraints is treated as a great “advance” in NCA5.

Other notes (so far)

- P. 2-13 US sea level rise relative to global average: role of land subsidence not acknowledged until after alarmist statement made
- KM 2.2 Extreme events becoming more frequent and severe: this is a blanket statement that needs heavy qualification as to time span and event type
- Mostly supported with reference to short data series
- Once again, refers to BDD data set (2-16)
- 2-17 on heat waves: see CWG discussion

- 2-18 rainfall extremes increasing since 1950s – no discussion of longer term metrics. See CWG discussion
- 2-24: extreme temperatures presented with focus on heat. Reduction in cold acknowledged but chapter asserts combined changes “very likely to have negative impacts on human health” despite cold being deadlier than heat

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CC: 'Judith Curry' [curry.judith@gmail.com]; 'John Christy' [climateman60@gmail.com]; 'Roy W. Spencer' [roywspencer@hotmail.com]; 'Travis Fisher' [travis.scott.fisher@gmail.com]; 'Josh Loucks' [loucksj14@gmail.com]
Subject: RE: Extreme scenarios
Attachments: image001.jpg

Yeah, funny how they never talk about that.

As I wrote in Unsettled about five years ago:

Global real GDP is assumed to grow strongly through the twenty-first century in all scenarios, by a factor of six in the higher-emitting scenarios, but by a factor of ten in the lower-emitting scenarios, presumably because a more prosperous world is able to place a higher priority on environmental matters. Since GDP grows by a larger multiple than population in all scenarios, the world in 2100 is projected to be more prosperous on a per capita (that is, per person) basis in any future (a detail often omitted from discussions of model results).

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I was asked to put some info together on SSP assumptions about economic changes. While probably not relevant to the NCA report, the data viewer at OurWorldinData makes it easy to see.

<https://ourworldindata.org/explorers/ipcc-scenarios?Metric=GDP&Rate=Per+capita&Region=Global>

What the climate crowd never mentions is that the "worst-case" SSP5 scenario assumes so much economic growth that by 2100 real global average per capita income will have risen 16x from \$8,700 to \$140,000! The poor countries in Africa will be at \$126,000, 4x richer than we are today. And this is the nightmare we are to avoid at all costs.

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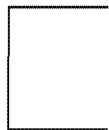
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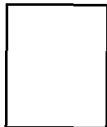
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On Jun 8, 2025, at 3:34 PM, Ross McKittrick <ross.mckittrick@gmail.com> wrote:

In the attached I have included a few interior sections I wrote on topics like emergent constraints, ECS, use of ad hoc time scales, etc., and then I decided to try to do some exterior framing using Steve's existing outline. Some of the topics that have been proposed might work either as rooms within wings or as entire wings. For instance the Overconfidence topic might fit in as examples of oversimplifications, in which case maybe the title I have applied to chapter 3 could be changed to Overconfidence when Stating Conclusions.

Also, in thinking about a concluding chapter, while we aren't in a position to make a legal ruling I'd like us to at least write some things down that should be considered by those who are. We can also offer thoughts as expert readers of the report and as citizens interested in good policy.

I didn't incorporate all the material currently in circulation but if we can tweak the attached structure we could soon converge on an overall report structure and then everyone can populate it with the material now available.

<NCA5.Review.[RM].June8.docx>



--
Judith Curry, President
CFAN - Climate Forecast Applications Network
Reno, NV USA
curry.judith@cfanclimate.com | +1.404.803.2012
<http://www.cfanclimate.net>

Overemphasis on extreme scenarios

To respond to the GCRA mandate to “project major trends for the subsequent 25 to 100 years,” projections of future climate change are driven by estimates of future emissions (SSP scenarios) and/or specified levels of radiative forcing (RCP scenarios). For the most part, NCA5 uses scenarios developed for the IPCC Assessment Reports.

NCA5 makes the following statements about future scenarios:

- “NCA5 authors were advised to assess the full range of scenarios available. (Front Matter)”
- “Scenarios of future emissions and land-use change are developed as plausible alternatives, but no relative likelihood is attached to them. Some recent studies, however, have argued that the highest scenario, SSP5-8.5, is no longer plausible without a reversal of current trends in the adoption of renewables and energy efficiency.” (Key Message 3.3 Traceable Analysis)

The NCA5 ignored a large body of literature (summarized in section xxx of the DOE Report) that shows the 8.5 and the 7.0 scenarios to be implausible, and advises against using them for policy making purposes. In 2021, UN Climate Negotiators (COP) stopped using scenarios above 4.5. The IPCC AR6 published in 2021 stated that "The likelihood of high-emission scenarios like RCP8.5 and SSP5-8.5 is considered low in light of recent energy sector developments."

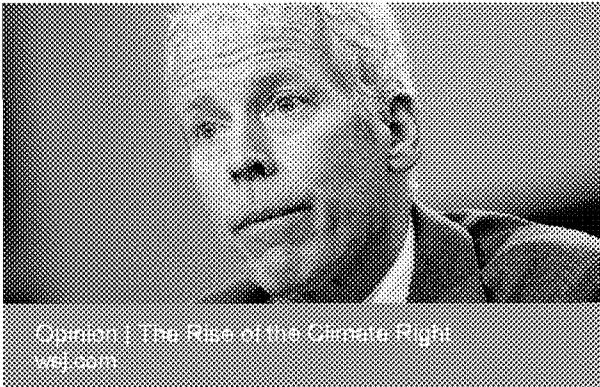
Even in the context of NCA5 being advised to assess the full range of scenarios available, a keyword search of the NCA5 of mentions of RCP/SSP scenarios finds over 50% referred to the extreme emissions scenarios RCP8.5/SSP5-8.5. Further, 10 figures only included the 8.5 scenarios: 5.2, 6.9, 7.4, 11.3, 14.6, 22.13, 22.19, 27.9, 29.13.

The inclusion, and even the focus, on implausible extreme emissions scenarios supports alarming impacts that are very unlikely to be driven by anthropogenic warming.

From: Roy Spencer <roywspencer@hotmail.com>
Sent: Thursday, July 31, 2025 11:25 PM
To: Steven Koonin; John Christy; Judith Curry; Travis Fisher; Josh Loucks; Travis Fisher; Andrea Woods
Subject: Re: Kim Strassel on the CWG report

This op-ed is pretty good.
-Roy

From: Steven Koonin <steven.koonin@gmail.com>
Sent: Thursday, July 31, 2025 6:59 PM
To: John Christy <climateman60@gmail.com>; Judith Curry <curry.judith@gmail.com>; Roy W. Spencer <roywspencer@hotmail.com>; Travis Fisher <travis.scott.fisher@gmail.com>; Josh Loucks <loucksj14@gmail.com>; Travis Fisher <travis.fisher@hq.doe.gov>; Andrea Woods <andrea.woods@hq.doe.gov>
Subject: Kim Strassel on the CWG report

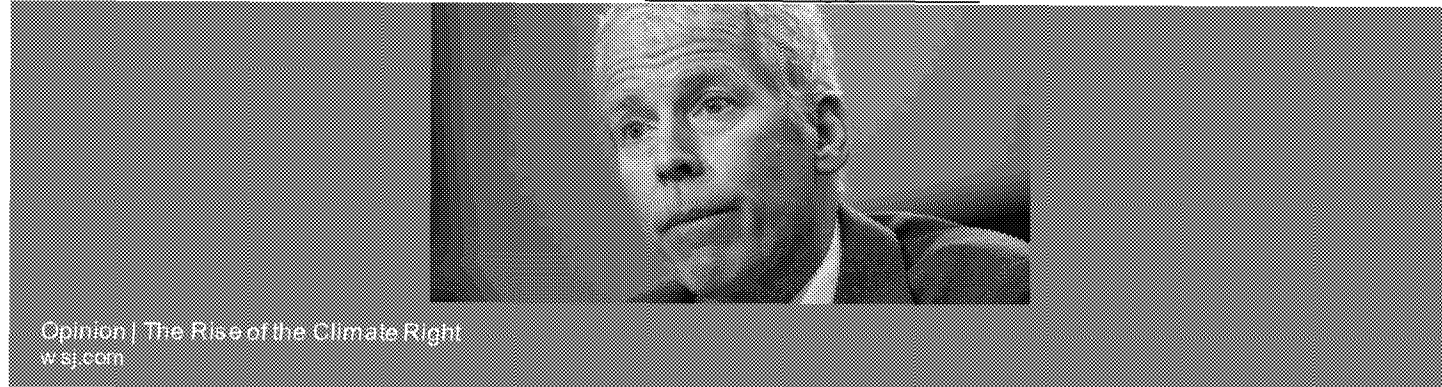


Steven E. Koonin

From: Judith Curry [curry.judith@gmail.com]
Sent: 8/1/2025 1:02:40 AM
To: Steven Koonin [steven.koonin@gmail.com]
CC: John Christy [climateman60@gmail.com]; Roy W. Spencer [roywspencer@hotmail.com]; Travis Fisher [travis.scott.fisher@gmail.com]; Josh Loucks [loucksj14@gmail.com]; Travis Fisher [travis.fisher@hq.doe.gov]; Andrea Woods [andrea.woods@hq.doe.gov]
Subject: Re: Kim Strassel on the CWG report

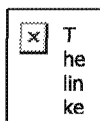
SUPERB article

On Thu, Jul 31, 2025 at 4:59 PM Steven Koonin <steven.koonin@gmail.com> wrote:



Steven E. Koonin

--



Judith Curry, President
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Reno, NV USA
curry.judith@cfanclimate.com | +1.404.803.2012
<http://www.cfanclimate.net>

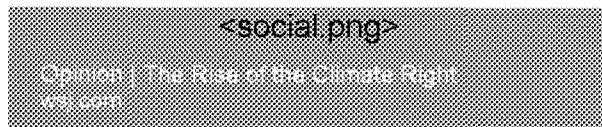
From: John Christy <climateman60@gmail.com>
Sent: Thursday, July 31, 2025 8:17 PM
To: Steven Koonin
Cc: Judith Curry; Roy W. Spencer; Travis Fisher; Josh Loucks; Travis Fisher; Andrea Woods
Subject: Re: Kim Strassel on the CWG report

My goodness. I like it.

John C.

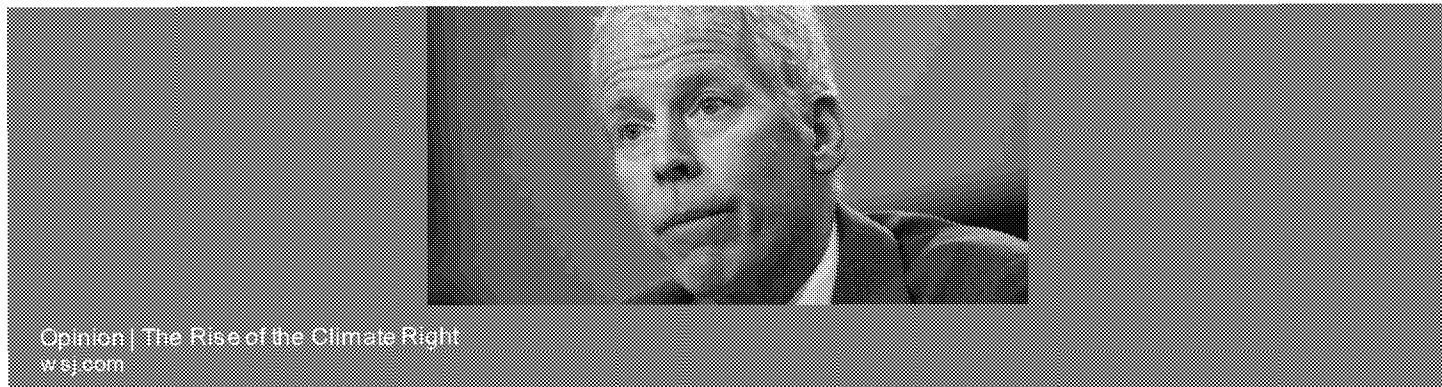
Sent from my iPhone

On Jul 31, 2025, at 6:59 PM, Steven Koonin <steven.koonin@gmail.com> wrote:



Steven E. Koonin

From: Steven Koonin [steven.koonin@gmail.com]
Sent: 7/31/2025 11:59:04 PM
To: John Christy [climateman60@gmail.com]; Judith Curry [curry.judith@gmail.com]; Roy W. Spencer [roywspencer@hotmail.com]; Travis Fisher [travis.scott.fisher@gmail.com]; Josh Loucks [loucksj14@gmail.com]; Travis Fisher [travis.fisher@hq.doe.gov]; Andrea Woods [andrea.woods@hq.doe.gov]
Subject: Kim Strassel on the CWG report



Steven E. Koonin

From: Seth Cohen [cohen.seth1994@gmail.com]
Sent: 6/5/2025 2:27:52 AM
To: John Christy [climateman60@gmail.com]; Seth.cohen@hq.doe.gov
CC: Steven Koonin [steven.koonin@gmail.com]; Judith Curry [curry.judith@gmail.com]; Travis Fisher [travis.scott.fisher@gmail.com]; Roy Spencer [roywspencer@hotmail.com]; Ross McKittrick [ross.mckittrick@gmail.com]; Josh Loucks [loucksj14@gmail.com]
Subject: PRIVILEGED & CONFIDENTIAL Re: NCA5 preface material

Hi all, please remember to drop this email address from the chain and to use my government email, cc'd here.

On Wednesday, June 4, 2025, John Christy <climateman60@gmail.com> wrote:

Steve

I've gone through the two pieces I wrote and made statements more clear. The map is also updated with now 61 stations in the upper Midwest.

Note the filename "...250604.X" for these latest versions.

John C.

On Wed, Jun 4, 2025 at 10:40 AM Steven Koonin <steven.koonin@gmail.com> wrote:

Yes, good to know.

I've also taken material from the prior page (xx, "About This Report") into the accumulating draft.

From: Judith Curry <curry.judith@gmail.com>
Sent: Wednesday, June 4, 2025 11:17 AM
To: Steven Koonin <steven.koonin@gmail.com>
Cc: Travis Fisher <travis.scott.fisher@gmail.com>; Roy Spencer <roywspencer@hotmail.com>; cohen.seth1994@gmail.com; Ross McKittrick <ross.mckittrick@gmail.com>; John Christy <climateman60@gmail.com>; Josh Loucks <loucksj14@gmail.com>
Subject: NCA5 preface material

There is important info before ch 1, in the pages with roman numerals. Notably, on p xxi they remark that for the physical science chapters they focus on advances since NCA4.

On Wed, Jun 4, 2025 at 7:43 AM Steven Koonin <steven.koonin@gmail.com> wrote:

Thanks, Judy. It will fit well into the preamble sections

From: Judith Curry <curry.judith@gmail.com>
Sent: Wednesday, June 4, 2025 10:30 AM
To: Steven Koonin <steven.koonin@gmail.com>
Cc: Travis Fisher <travis.scott.fisher@gmail.com>; Roy Spencer <roywspencer@hotmail.com>;

cohen.seth1994@gmail.com; Ross McKittrick <ross.mckitrick@gmail.com>; John Christy
<climateman60@gmail.com>; Josh Loucks <loucksj14@gmail.com>

Subject: text for intro

Attached is some text for the intro (not obvious where this would fit in Steve's outline)

NCA5's Interpretation of its Mission

:



Judith Curry, President
CFAN - Climate Forecast Applications Network
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<http://www.cfanclimate.net>

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From: Steven Koonin [steven.koonin@gmail.com]
Sent: 6/7/2025 8:24:46 PM
To: 'Judith Curry' [curry.judith@gmail.com]
CC: 'John Christy' [climateman60@gmail.com]; 'Ross McKittrick' [ross.mckittrick@gmail.com]; 'Roy W. Spencer' [roywspencer@hotmail.com]; 'Travis Fisher' [travis.scott.fisher@gmail.com]; 'Josh Loucks' [loucksj14@gmail.com]
Subject: RE: NCA5 metadata
Attachments: ~WRD1228.jpg; image001.png

My guess we won't get a response from USGCRP (or at least one with any meaning). The prior team has been disbanded with the change in Administration, don't think there's a Director, etc. So nobody to answer for past sins.

SEK

From: Judith Curry <curry.judith@gmail.com>
Sent: Saturday, June 7, 2025 2:03 PM
To: Steven Koonin <steven.koonin@gmail.com>
Cc: John Christy <climateman60@gmail.com>; Ross McKittrick <ross.mckittrick@gmail.com>; Roy W. Spencer <roywspencer@hotmail.com>; Travis Fisher <travis.scott.fisher@gmail.com>; Josh Loucks <loucksj14@gmail.com>
Subject: NCA5 metadata

Now this is interesting, not sure if others have spotted this

From the NCA5 description of Traceable Accounts, they include this text

Each figure and some tables are accompanied by a metadata survey, which can be accessed in the online version of the report by clicking on the eyeball icon above the figure or table (see the table below for explanations of additional icons used throughout the report). The metadata survey describes data sources, figure or table development methods, copyright information, and other important documentation. All figures that appear in the online version of the report are also accompanied by alternative text for screen readers

So I clicked on the eyeball icon for a generic figure from Chapter 2, and this is what i get



So then i clicked on contact us, and it generates a generic email to USCRP. We should kick the tires on this one and see what they send. Does anyone want to try this or suggest a figure that I could pursue?

--



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<http://www.cfanclimate.net>

From: Judith Curry <curry.judith@gmail.com>
Sent: Saturday, June 7, 2025 2:03 PM
To: Steven Koonin
Cc: John Christy; Ross McKittrick; Roy W. Spencer; Travis Fisher; Josh Loucks
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<http://www.cfanclimate.net>

From: Steven Koonin <steven.koonin@gmail.com>
Sent: Thursday, August 21, 2025 6:54 PM
To: Jeremy T. Ison
Cc: Judith Curry; Ross McKittrick; Roy Spencer; John Christy; Audrey Barrios
Subject: Re: [EXTERNAL] RE: catchup call?

Great. I think it would be good to keep team momentum up, even if all the answers aren't in.

I could make either time tomorrow, as well as sometime on Monday

What about the rest of the team?

Steven E. Koonin

On Aug 21, 2025, at 18:45, Ison, Jeremy T. <jeremy.ison@hq.doe.gov> wrote:

Steve,

Thank you for reaching out and apologies on the delay, as I was out of the office today.

I was waiting for the completion of some internal discussions before setting up this meeting, but happy to get together and address what I can.

I can meet tomorrow from 9-10:30am and then again at 4pm ET.

I can generally make myself available all of Monday for this discussion and may have more to share at that time.

Thank you,
Jeremy

From: Steven Koonin <steven.koonin@gmail.com>
Sent: Thursday, August 21, 2025 5:54 PM
To: Ison, Jeremy T. <jeremy.ison@hq.doe.gov>
Cc: 'Judith Curry' <curry.judith@gmail.com>; 'Ross McKittrick' <ross.mckittrick@gmail.com>; 'Roy Spencer' <roywspencer@hotmail.com>; 'John Christy' <climateman60@gmail.com>; Barrios, Audrey <audrey.barrios@hq.doe.gov>
Subject: [EXTERNAL] RE: catchup call?

Jeremy – following up on this as the CWG sees some urgency in having a discussion. After on last week's call, we thought you were going to arrange one this week.

Here are some of the issues we'd like to discuss:

- Release all the public comments submitted so far on the CWG report (we have spotted 200 that have been released in the Federal Register docket, but there are more than 200 still to go)
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- We would like an update on the status of the NCA5 Review, and whether the charge for that has changed.
- Curry does not yet have a contract
- Christy and Spencer's SGE appointments have just ended

Steve

From: Steven Koonin <steven.koonin@gmail.com>

Sent: Thursday, August 21, 2025 11:34 AM

To: Ison, Jeremy T. <jeremy.ison@hq.doe.gov>

Cc: 'Judith Curry' <curry.judith@gmail.com>; 'Ross McKittrick' <ross.mckittrick@gmail.com>; 'Roy Spencer' <roywspencer@hotmail.com>; 'John Christy' <climateman60@gmail.com>; 'Barrios, Audrey' <audrey.barrios@hq.doe.gov>

Subject: catchup call?

Jeremy –

Could we do a call sometime soon (today, tomorrow, or early next week) to catch up on recent events and map out plans going forward?

Steve Koonin

This message does not originate from a known Department of Energy email system.
Use caution if this message contains attachments, links or requests for information.

From: Ison, Jeremy T. <jeremy.ison@hq.doe.gov>
Sent: Thursday, August 21, 2025 6:45 PM
To: Steven Koonin
Cc: 'Judith Curry'; 'Ross McKittrick'; 'Roy Spencer'; 'John Christy'; Barrios, Audrey
Subject: Re: [EXTERNAL] RE: catchup call?

Steve,

Thank you for reaching out and apologies on the delay, as I was out of the office today.

I was waiting for the completion of some internal discussions before setting up this meeting, but happy to get together and address what I can.

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From: Steven Koonin <steven.koonin@gmail.com>
Sent: Thursday, August 21, 2025 5:54 PM
To: Ison, Jeremy T. <jeremy.ison@hq.doe.gov>
Cc: 'Judith Curry' <curry.judith@gmail.com>; 'Ross McKittrick' <ross.mckittrick@gmail.com>; 'Roy Spencer' <roywspencer@hotmail.com>; 'John Christy' <climatemanager60@gmail.com>; Barrios, Audrey <audrey.barrios@hq.doe.gov>
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Steve

From: Steven Koonin <steven.koonin@gmail.com>

Sent: Thursday, August 21, 2025 11:34 AM

To: Ison, Jeremy T. <jeremy.ison@hq.doe.gov>

Cc: 'Judith Curry' <curry.judith@gmail.com>; 'Ross McKittrick' <ross.mckittrick@gmail.com>; 'Roy Spencer' <roywspencer@hotmail.com>; 'John Christy' <climateman60@gmail.com>; 'Barrios, Audrey' <audrey.barrios@hq.doe.gov>

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Use caution if this message contains attachments, links or requests for information.

From: Steven Koonin <steven.koonin@gmail.com>
Sent: Thursday, August 21, 2025 5:54 PM
To: 'Ison, Jeremy T.'
Cc: 'Judith Curry'; 'Ross McKittrick'; 'Roy Spencer'; 'John Christy'; 'Barrios, Audrey'
Subject: RE: catchup call?

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Sent: Thursday, August 21, 2025 11:34 AM
To: Ison, Jeremy T. <jeremy.ison@hq.doe.gov>
Cc: 'Judith Curry' <curry.judith@gmail.com>; 'Ross McKittrick' <ross.mckittrick@gmail.com>; 'Roy Spencer' <roywspencer@hotmail.com>; 'John Christy' <climateman60@gmail.com>; 'Barrios, Audrey' <audrey.barrios@hq.doe.gov>
Subject: catchup call?

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Steve Koonin

From: Steven Koonin <steven.koonin@gmail.com>
Sent: Thursday, August 21, 2025 11:34 AM
To: Ison, Jeremy T.
Cc: 'Judith Curry'; 'Ross McKittrick'; 'Roy Spencer'; 'John Christy'; 'Barrios, Audrey'
Subject: catchup call?

Jeremy –

Could we do a call sometime soon (today, tomorrow, or early next week) to catch up on recent events and map out plans going forward?

Steve Koonin

From: John Christy <climateman60@gmail.com>
Sent: Thursday, June 12, 2025 4:52 PM
To: Ross McKittrick
Cc: Steven Koonin; Judith Curry; Roy W. Spencer; Travis Fisher; Josh Loucks
Subject: Re: JUne 11 draft

Ross

I think it means - Make a map. Do significance testing on each grid (gaussian no doubt). Mask out the ones that are insignificant. Give the remaining grids a really bright, angry color to frighten the readers.

John C.

On Thu, Jun 12, 2025 at 3:14 PM Ross McKittrick <ross.mckittrick@gmail.com> wrote:
I agree that a separate chapter on the NASEM review would be an excellent addition.
John - I've no idea what "masking by T test means"

On Thu, Jun 12, 2025 at 3:17 PM John Christy <climateman60@gmail.com> wrote:
All

I may be able to join you for a bit tomorrow at 0700 CT before we head to the airport.

I just reread the NASEM review of NCA5 Ch2 "Climate Trends". This was almost as stomach-churning as reading the NCA5 itself - a very soft review and just weird.

For example, on assessing Key Message 2.3 "The Future is in Our Hands" here is NASEM's comment.

"This key message title is not scientific and seems to ignore equity and justice concerns on the very question of who has the power in the United States to shape climate and energy policy."

Huh? Of course we could ask why such a Key Message is in something called "Climate Trends" in the first place. And, why does the discussion of this "Key Message" take up half of the chapter text?

Ross

Tucked inside a rambling paragraph was this from the NASEM review of Ch 2 which rather vaguely requests significance indicators.

"In addition, showing how temperature and precipitation changes (in degrees and by percent from the average) compared to the natural variabilities (e.g., masking by T test) would be helpful."

This seems to be a request for some kind of significance testing (masking by T test, whatever that means), but the figures on changes and percentages didn't have any significance that I could see (Figs 2.4, 2.7, 2.8). They actually spend more time on future trends from models than on the historical trends (Figs. 2.9 - 2.14) in this chapter.

Judy

Did you see this NASEM comment at the end of Chapter 2 review which seems to dissect the SLR portion about which you wrote? :

It is unclear how the reported amounts of averaged SLR along the continental United States (CONUS) coasts were obtained on page 2-24 lines 32-34. Assuming the source is Sweet et al. (2022), the values reported here are not provided explicitly in that reference. One could look at Table 2.4 in Sweet et al. (2022) and see that 2°C warming most closely corresponds to the Intermediate Low Scenario (50%), while the Low and Intermediate scenarios correspond to the tails of the probability distribution (98% and 2%, respectively). Chapter authors could then look at Table 2.3 in Sweet et al. (2022) and find a Low to Intermediate range for CONUS average sea level of 0.6-1.2 m (2-4 ft) in 2100 and 0.8-2.2 m (2.5-7 ft) in 2150. Both ranges differ from the ranges given in the draft NCA5 report. For page 2-24, lines 36-37, the Committee assumes this statement is based on the Intermediate scenario, but the Intermediate scenario is just as likely from a probability standpoint as the Low scenario for 2°C warming. So, if it is very unlikely that CONUS SLR will exceed 4 feet in 2100 for 2°C warming, then it is also very unlikely it will be as low as 2 feet, which is reported as the lower bound of what appears to be a likely range two sentences prior. This section needs work to be internally consistent with the draft NCA5 report likelihood ranges, as well as Sweet et al. (2022) on which it is based.

John C.

On Wed, Jun 11, 2025 at 10:17 PM Steven Koonin <steven.koonin@gmail.com> wrote:

Thanks, Ross.

I won't be able to get to this until Friday, but it looks like we'll have the weekend to progress the text.

Steve

PS In case you all missed it, EPA/Zeldin today announced a relaxation of power plant emission rules:

https://www.wsj.com/politics/policy/epa-air-pollution-standards-repeal-1f85bf91?st=HnJKTD&reflink=desktopwebshare_permalink

From: Ross McKittrick <ross.mckittrick@gmail.com>

Sent: Wednesday, June 11, 2025 11:01 PM

To: Steven Koonin <steven.koonin@gmail.com>

Cc: Judith Curry <curry.judith@gmail.com>; Roy W. Spencer <roywspencer@hotmail.com>; John Christy

<climateman60@gmail.com>; Travis Fisher <travis.scott.fisher@gmail.com>; Josh Loucks <loucksj14@gmail.com>

Subject: Re: JUne 11 draft

I went through both and did my best to merge them in the attached. Steve some of your comments pertained to text removed in the draft after Judy's comments; also the extreme scenarios text in the attached is as revised by Judy with a bit of your new wording subbed in. Also you had requested some clarifications in a few places so I have added those in. If there were sections where you made changes without track changes on I might not have caught them so check this version. Also this version has the latest re-ordering of sections.

On Wed, Jun 11, 2025 at 8:40 PM Steven Koonin <steven.koonin@gmail.com> wrote:

Oh, we're doing double work.

The attached is my latest integrated version, incorporating almost all of the changes Ross sent out yesterday, and my going through all of the sections.

We somehow need to reconcile these two.

SEK

From: Ross McKittrick <ross.mckittrick@gmail.com>

Sent: Wednesday, June 11, 2025 6:48 PM

To: Judith Curry <curry.judith@gmail.com>; Roy W. Spencer <roywspencer@hotmail.com>; John Christy <climateman60@gmail.com>; Steven Koonin <steven.koonin@gmail.com>; Travis Fisher <travis.scott.fisher@gmail.com>; Josh Loucks <loucksj14@gmail.com>

Subject: JUne 11 draft

The attached incorporates all of Judy's suggestions including deletions and John's edits of Sect 4.2. I also dealt with Steve's various comments in the opening section as best I could. Did some additional editing, including adding in Roy's word search data. John you had suggested some additional text for the NCA4 magic ratio diagram but I think the example works best if we keep the writeup as simple as possible.

I am not sure Chapter 7 (biased references) is needed unless someone plans to write it up.

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Sent: Thursday, June 12, 2025 4:15 PM
To: John Christy
Cc: Steven Koonin; Judith Curry; Roy W. Spencer; Travis Fisher; Josh Loucks
Subject: Re: JUne 11 draft

I agree that a separate chapter on the NASEM review would be an excellent addition.
John - I've no idea what "masking by T test means"

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To help protect
your privacy,
Microsoft Office
prevented
automatic
download of this
picture from the
Internet.

Judith Curry, President
CFAN - Climate Forecast Applications Network
Reno, NV USA
curry.judith@cfanclimate.com | +1.404.803.2012
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Attachments: NCA5.Review.[RM][SK].June11.docx

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Review of the Fifth National Climate Assessment

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1 INTRODUCTION

1.1 About this Report

This report responds to a request from OSTP Director Michael Kratsios (reproduced in Appendix XX) that we assess the suitability of the Fifth National Climate Assessment for informing climate and energy policies.

To conduct this assessment we reviewed NCA5 itself, NASEM review of the Third Order Draft and the USGCRP responses to the review. We have drawn upon our long experience working on advisory reports, including for the NASEM, IPCC and other organizations, as writers, reviewers and project leaders.

Our report begins with background on the National Climate Assessments. We then discuss the standards by which we have assessed NCA5, followed by specific deficiencies that we have identified

We find that NCA5 should not be relied on for policy making as it is an incomplete and misleading picture of our understanding of the changing climate and the risks it poses to the nation. NCA5 was selective and incomplete in its survey of the science as of its publication date in 2023 and has become even more so in the years since. We have reviewed many key scientific developments in a separate report to Energy Secretary Wright (Climate Working Group 2025, herein denoted “CWG25”). The overall effect of the biases and omissions of NCA5 is an excessively dire picture of climate risk.

1.2 About the National Climate Assessments

The U.S. Global Change Research Program (USGCRP) was established by Presidential Initiative in 1989 and mandated by Congress in the Global Change Research Act (GCRA) of 1990 to develop and coordinate “a comprehensive and integrated United States research program which will assist the Nation and the world to understand, assess, predict, and respond to human-induced and natural processes of global change.”

The National Climate Assessment (NCA) Reports evolved from the GCRA requirement to

Prepare and submit to the President and the Congress an assessment which (1) integrates, evaluates, and interprets the findings of the Program and discusses the scientific uncertainties associated with such findings; (2) analyzes the effects of global change on the natural environment, agriculture, energy production and use, land and water resources, transportation, human health and welfare, human social systems, and biological diversity; and (3) analyzes current trends in global change, both human-induced and natural, and projects major trends for the subsequent 25 to 100 years.

The five NCA Reports to date have interpreted this mandate in different ways:

- NCA1 (2000) was a multidisciplinary effort to study and portray in regional detail the potential effects of human-induced global warming on the United States.
- NCA2 (2009) was a relatively short report that not only focused on the potential consequences of climate change, but also sought to identify potential adaptation measures and identify the highest priorities for future research.
- NCA3 (2014) was an expanded effort that continued along the lines of NCA2, and was distinguished by a comprehensive review process, including a review by the National

Academy of Sciences. NCA3 introduced a traceability analysis for each key finding, including a description of uncertainties.

- NCA4 (2017/2018) was an expanded effort published in two volumes: I Climate Science Special Report, and II Impacts, Risk, and Adaptation in the United States. This was the first NCA report to devote significant effort to assessing climate science.
- NCA5 (2023) returned to a single volume format, reducing discussion of climate science to a cursory two chapters, with continuing with a focus on regional and sectoral impacts of climate change. NCA5 expanded its remit to topics that are arguably outside the purview of the USGCRP, focusing on “Climate Action” and policy recommendations with a social justice emphasis. NCA5’s self-description is reproduced as Appendix II.

These successive interpretations of the NCA are poorly aligned with the GCRA’s statutory requirements. Only NCA4 gives serious consideration to climate science, which receives the great majority of USGCRP funding, and even then misrepresents some important points. Natural climate variability is essentially dismissed as unimportant in NCA4 and barely mentioned in NCA5 in most contexts, despite the mandate to include both human-caused and natural climate change. Most significantly, NCA5 has redirected the focus away from climate science and even the hazard elements of impacts, towards evaluation of societal vulnerabilities and advocacy for particular policy options, especially wind and solar power. The cover image for the NCA5 Report is the installation of a solar panel.

1.3 Standards for Assessing NCA Products

In Appendix XX we include a letter of guidance from the Office of General Counsel, U.S. Department of Energy, summarizing the extent of statutory requirements governing USGCRP work products in general and NCA products in particular.

We can summarize the standards applicable to the NCA as follows:

- details.

Beyond the statutory requirements we draw attention to two other pertinent standards. President Trump’s executive order of May 23, 2025, “Restoring Gold Standard Science” enumerates some of the characteristics of good science:

- i. reproducible;
- ii. transparent;
- iii. communicative of error and uncertainty;
- iv. collaborative and interdisciplinary;
- v. skeptical of its findings and assumptions;
- vi. structured for falsifiability of hypotheses;
- vii. subject to unbiased peer review;
- viii. accepting of negative results as positive outcomes; and
- ix. without conflicts of interest.

Although these should be self-evident to those trained in science, it is surprising that some have found them controversial.

When scientific reports are being assembled that will be highly influential on climate policymaking there are other desiderata, including statements about the strength of climate knowledge. The IPCC's approach is based on judgment of the available evidence and agreement among experts. More sophisticated knowledge characterizations for risk management include (Aven 2017)¹:

- The degree to which the assumptions made are reasonable/realistic based on background knowledge
- The degree to which data/information exists and are reliable and relevant
- The degree to which there is disagreement among experts (including those from different environments or academic fields)
- The degree to which the phenomena involved are understood and accurate models exist
- The degree to which the knowledge has been thoroughly examined with respect to unknown knowns

Good climate and energy policies will balance the risks and benefits of a changing climate against the world's growing demand for reliable and affordable energy. To strike that balance, policymakers must understand at least two complex and nuanced topics: the certainties and uncertainties of climate science and the technoeconomic realities of energy systems. Experts in those subjects have a unique responsibility to communicate their understanding to non-experts clearly, completely, and without bias.

Expertise in energy systems resides largely in the private sector, where it is essential to providing the reliable and affordable energy services that are the lifeblood of society. Understanding is therefore continually refined and tested by the discipline of the marketplace. In contrast, climate science expertise is found largely in the non-profit realm of universities and government laboratories and so has a more academic character.

In recent decades, climate science has engendered passion and emotion. Indeed, some younger climate scientists have gone into the field to "save the planet." So it is not surprising that objectivity can suffer when climate scientists communicate their understanding to non-experts. Further, the field of climate science has been politicized by NetZero mandates. This lack of objectivity usurps the public's right to make informed choices and undermines their confidence in the scientific enterprise.

In 1980, then-President of the National Academy of Sciences Philip Handler identified the problem in an editorial² that resonates eerily four decades later:

Difficulty arises in the scientific community from confusion of the role of scientist *qua* scientist with that of scientist as citizen, confusion of the ethical code of the scientist with the obligation of the citizen, blurring the distinction between intrinsically scientific and intrinsically political questions. When scientists fail to recognize these boundaries, their own ideological beliefs, usually unspoken, easily becloud seemingly scientific debate.

¹ Aven, Terje (2017) "Improving Risk Characterisations in Practical Situations by Highlighting Knowledge Aspects, with Applications to Risk Matrices," *Reliability Engineering & System Safety* 167 (November 2017): 42–48 <https://www.sciencedirect.com/science/article/pii/S0951832016306950>

² Handler, Philip (1980) Public Doubts About Science. *Science* 208(4448) p. 1093 <https://www.science.org/doi/10.1126/science.208.4448.1093>

1.4 When Peer-Review Fails

Peer-review of reports like IPCC and NCA products is not a silver bullet that guarantees quality. The peer review process for these reports differs in some important respects from traditional peer review in academic journals. First, NCA reviewers self-select on a volunteer basis whether to provide comments and what parts of the report to read, whereas in academic journals Editors recruit reviewers and assign them to specific papers. There is no guarantee that any particular section of an NCA report was reviewed by anyone, let alone by someone with a different perspective than the authors. This is a problem with NCA and IPCC reports since over the years many potential reviewers have given up making the effort, because their input has systematically been ignored. Second, NCA authors have near complete authority whether to accept or reject review comments. Here, for example, is how a review comment critical of a section of the NCA5 draft was handled by the authors:

By contrast in academic journals the Editor mandates the author to respond and the reviewer gets to assess its adequacy. Once an NCA chapter author team has been selected publication of their work is guaranteed, whereas academic journals routinely reject papers if they do not pass review.

These points are important to bear in mind because some readers might dismiss any criticism of NCA products out of hand on the grounds that they were “peer reviewed”. But the test of a report is whether its contents are a valid representation of the available evidence. Here we give an example in which NCA4 gave prominence to a Figure that completely misrepresented the underlying data and which evaded peer review to do so. Further details can be found in Koonin (2024).

As we pointed out in CWG25 Section 6.3 the number of heat extremes in the U.S. peaked in the 1930s and has declined ever since. Considering cold and hot extremes together the U.S. the U.S. climate has become more moderate over time. NCA4’s Part I (Climate Science Special Report, CCSR) says (prominently and with *Very High Confidence*) on Page 19 of the Executive Summary:

There have been marked changes in temperature extremes across the contiguous United States. The number of high temperature records set in the past two decades far exceeds the number of low temperature records.

and offers this figure in support:

Record Warm Daily Temperatures Are Occurring More Often

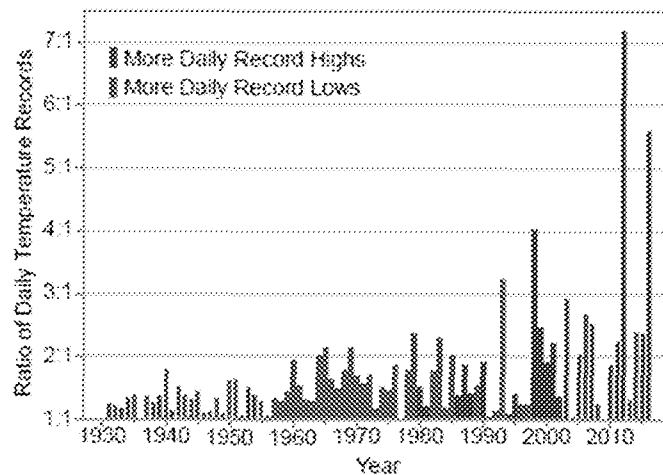
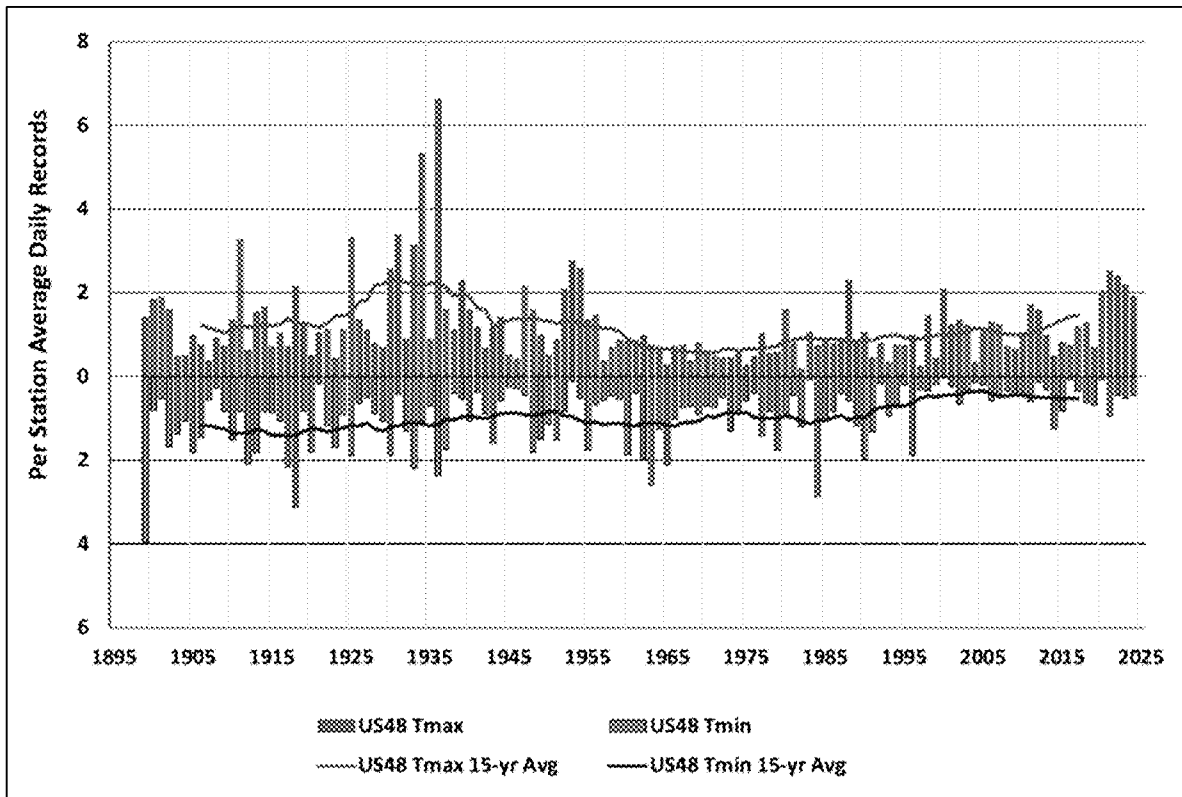


Figure ES.5: Observed changes in the occurrence of record-setting daily temperatures in the contiguous United States. Red bars indicate a year with more daily record highs than daily record lows, while blue bars indicate a year with more record lows than highs. The height of the bar indicates the ratio of record highs to lows (red) or of record lows to highs (blue). For example, a ratio of 2:1 for a blue bar means that there were twice as many record daily lows as daily record highs that year. (Figure source: NOAA/NCEI). From Figure 6.5 in Chapter 6.

The Figure appears to validate the claim that record warm daily temperatures are occurring more often. But the underlying data do not: they show that extreme heat in the U.S. peaked in the 1920s and 1930s and declined thereafter, as NCA4 Figure 6.4 itself later shows.

Figure ES.5 does not show what its title implies: these are not simple counts of cold and warm extreme events; instead they are ratios of the two. In fact, both types of extremes declined over the sample interval, but cold events declined more than warm events, so the ratio of warm extremes to cold extremes increased. By graphing the ratio in this way the NCA4 created a visual impression opposite to what is in the data.

Figure 6.3.3 of CWG25 (reproduced below) shows the results of a proper analysis of the data – defining each record as the singular extreme in the history, displaying numbers of warm and cold records separately, and beginning the analysis in 1899 rather than 1930. It makes evident the exceptional heat of the 1920s and especially the 1930s, peaking in 1936. The increased heat of the past five years is too brief to be deemed climatically significant and, in any event, occurred after the CSSR was published in 2017. The frequency of cold records has declined, especially over the last quarter of the period in which only 13 percent of the extreme cold events were measured. In contrast, 25 percent of the extreme Tmax records were achieved in the last quarter, which is consistent with statistical expectations. As a result, the ratio of heat to cold extremes shown in Figure ES.5 of the CSSR explodes in recent decades. The overall reduction in numbers of both cold and hot extremes over the past century indicates a climate *less* prone to extremes, in sharp contrast to the message of the NCA4 Figure ES.5.



Number of daily record High (red) and Low (blue) temperatures for warm and cold seasons in the CONUS. The lines represent the 15-year running, centered average. Source: 1,211 USHCN stations supplemented as needed to achieve a minimum of 92 percent of observations in the 126-year period since Dec 1898. US48: contiguous U.S. states. Tmax: maximum temperature. Tmin: minimum temperature. Source: CWG25 Figure 6.3.3.

The National Academies' expert review panel criticized the discussion of temperature extremes in a late draft of the CSSR. In reference to the CSSR's Key Finding 2 of Chapter 6, they said:

Further, it is difficult to understand how a statement that includes increases in extreme warmth can be associated with a high confidence or extremely likely statement, given that most of the graphics in this chapter show a decrease in extreme warmth in the historical record.

The Federal official in charge of the CSSR (Michael Kuperberg, Executive Director of the USGCRP) responded to the Academies' review by noting that

Almost every recommendation from the NAS was incorporated [in the final version]... and a new figure was added on changes in record high and low temperatures

The "new figure" referred to is the Figure ES.5, which did not appear in the draft reviewed by the Academies' panel. It seems unlikely that the Academies panel ever saw that figure because they surely would have commented if they had and it wouldn't have survived to publication. And the

figure's problems were evidently not flagged (or were ignored) in the subsequent internal government reviews.

With this background we now present our critique of NCA5.

2 NCA5 OVERVIEW CHAPTER: HYPERBOLIC ADVOCACY LANGUAGE AND NON-SCIENTIFIC TONE

NCA5 Chapter 1 “Overview” holds a prominent place in the Report since it summarizes the whole report and is the only section that many will read. Although the later Chapters of NCA5 contain much sound scholarly content, Chapter 1 is marred by a pervasive tone and language that aggressively promotes emission reduction policies. As such, this chapter adds an imprimatur of scientific authority to oversimplified declarations of opinion about public policy. Many examples can be cited; here we note a few that are particularly egregious.

Chapter 1 opens as follows:

The more the planet warms, the greater the impacts. Without rapid and deep reductions in global greenhouse gas emissions from human activities, the risks of accelerating sea level rise, intensifying extreme weather, and other harmful climate impacts will continue to grow. Each additional increment of warming is expected to lead to more damage and greater economic losses compared to previous increments of warming, while the risk of catastrophic or unforeseen consequences also increases.

This statement presupposes that: all warming is anthropogenic in origin, all warming is bad and causes economic damage, warming causes extreme weather to intensify. Such sweeping generalizations go well beyond what science has or can establish. It also refers to growing risks without saying whether they were large to begin with: a small risk that grows may still be a small risk. A scientifically-sound version of this paragraph would instead say something like the following:

The Earth is warming because of a combination of natural and anthropogenic influences. This warming will generate a mix of benefits and harms that varies by region, to which society should be prepared to adapt. Some types of extreme weather have worsened recently, while others have not changed or have even declined in intensity. Reducing emissions of greenhouse gases might slow the warming although such policies have proven to be costly and disruptive, so any climate actions to be weighed against the potential benefits.

On the next page the Overview goes on to say:

Each additional increment of warming leads to greater risks [here it lists 7 key components of society including food security and the economy]... Without deeper cuts in global net emissions, climate risks to the US will continue to grow... Action to limit future warming and reduce risks can have near-term benefits and opportunities: low-carbon energy jobs, Improved air quality, Health benefits, Economic benefits...”

The authors write as if climate policy does not involve trade-offs and all measures to reduce future warming will be effective and beneficial. But the vast body of scholarship on climate science and economics does not support such simplistic claims. Not every additional increment of warming leads to economic harms, indeed (as is acknowledged in Chapter 19 on Economics) in some cases there will be benefits. Nor is climate policy guaranteed to create jobs or benefit the economy; in many cases it has done the opposite. Such deceit is a disservice to policymakers.

Pages 8 and 9 promote renewable energy options by noting, correctly, that the levelized costs of wind/solar generation have fallen sharply since 2010. This is proposed as rationale for pursuing deep emission reductions:

Recent growth in the capacities of wind, solar, and battery storage technologies is supported by rapidly falling costs of zero- and low-carbon energy technologies, which can support even deeper emissions reductions. For example, wind and solar energy costs dropped 70% and 90%, respectively, over the last decade, while 80% of new generation capacity in 2020 came from renewable sources.

Yet it has long been known that intermittent renewables generation must be supplemented by dispatchable generation to meet grid reliability standards, and that doing so (e.g., through natural gas, fission, or storage) can substantially increase the cost of electricity. Further, there are yet unmet synchronization challenges in transmission grids with heavy penetration of wind and solar power. Here again it is advisory malpractice not to acknowledge these facts.

Page 14 presents future emission scenarios with the following description: “Climate modeling experts develop global climate projections for a range of plausible futures.” The word “plausible” is applied to all the scenarios. The accompanying Figure includes both SSP3-7.0 and SSP5-8.5, the latter reaching the same radiative forcing as RCP8.5. The figure does not contrast observed emissions against previous projections nor does it caution readers that SSP3-7.0 and SSP5-8.5 are extreme worst case scenarios that, like RCP8.5, have been heavily criticized in the scientific literature (CWG25 3.2.1). By describing the entire envelope of emission projections as “plausible” the report opens the door to later presenting impacts associated with extreme and implausible emission scenarios as part of a baseline “business-as-usual” future.

Page 17 introduces the discussion of risks from extreme weather events by saying “Harmful impacts from more frequent and severe extremes are increasing across the country.” This creates the impression that disaster losses are driven by trends in extreme weather. While the section goes on to acknowledge that some of the increase is due to increases in the value of assets at risk it then invokes the NOAA Billion Dollar Dataset as evidence of extreme weather getting worse. Scientists have shown that this is an invalid metric (CWG 10.2) since it measures the growth of the economy not the frequency of extreme weather, and indeed NOAA has recently withdrawn the data product. Even though it was still distributed by NOAA at the time of the NCA5, the report authors should have assessed it skeptically and seen that it was unfit for the purpose of measuring climate trends and they should have taken care not to conflate extreme weather metrics with economic trends.

Page 23 states, in large font:

Climate changes are making it harder to maintain safe homes and healthy families; reliable public services; a sustainable economy; thriving ecosystems, cultures, and traditions; and strong communities.

It is pointless to try to evaluate this statement on scholarly grounds; it is self-evidently hyperbolic. This kind of language doesn’t belong in a scientific assessment report. Its prominent inclusion points not only to the willingness of NCA5 authors to promote hysteria, but also the ineffectiveness of the review process at not ensuring such statements are removed.

The tone of the Overview chapter hints at the priorities that governed the writing of the report as a whole. As a crude indicator of these priorities, word searches of the full document revealed the following occurrences:

Term	Number of occurrences
Forcing	111
Uncertainty	384
Watts	19
Culture/culturally	854
Equity/equitable	572
Indigenous	890
Sustainable	295
Racism/racial	153

3 OVERCONFIDENCE WHEN STATING CONCLUSIONS

3.1 Inflated certainty levels

A general pattern in the NCA5 is overconfidence in stating conclusions. The authors frequently make sweeping generalizations without appropriate caveats or acknowledging uncertainties. The overconfidence begins with inflated language to describe certainty levels.

The NCA5 uses specific terms to convey information about scientific confidence associated with important finds, observations and projections. The Front Matter of the NCA5 states that “confidence in a finding is based on the type, amount, quality, strength, and consistency of evidence; the skill, range, and consistency of methods to detect, evaluate, attribute, and interpret climate trends; and the degree of agreement across scientific information sources.”

Table 1 from the Front Matter provides calibrated language for confidence assessment:

Very high:	Strong evidence (established theory, multiple sources, well documented and accepted methods, etc.). High consensus
High:	Moderate evidence (several sources, some consistency, methods vary and/or documentation limited, etc.). Medium consensus
Medium:	Suggestive evidence (a few sources, limited consistency, methods emerging, etc.) Competing schools of thought.
Low:	Inconclusive evidence (limited sources, extrapolations, inconsistent findings, poor documentation and/or methods not tested, etc.). Disagreement or lack of opinions among experts.

This terminology is inflated: *high confidence* with just moderate evidence and medium consensus; *medium confidence* with only suggestive evidence and competing schools of thought. This inflation in terminology leads to overconfidence in the conclusions.

Even within the context of this inflated terminology, NCA5 further inflates the confidence level of many of its conclusions to well beyond what the IPCC has concluded with more thorough justification, and also by incorrectly applying its own standards. Several illustrative examples are provided.

Key Message 3.1 Traceable Account states:

“There is *very high confidence* that emissions of GHGs from human activities, fossil fuel use in particular, have unequivocally caused *all* global warming observed over the industrial era.”

Compare this statement with statements from the IPCC AR5 and AR6:

AR5: “It is *extremely likely* that *more than half* of the observed increase in global average surface temperature from 1951 to 2010 was caused by the anthropogenic increase in greenhouse gas concentrations and other anthropogenic forcings together.” (IPCC, 2013)

AR6: The *likely* range of total human-caused global surface temperature increase from 1850–1900 to 2010–2019 is 0.8°C to 1.3°C, with a best estimate of 1.07°C. It is *likely* that well-mixed GHGs contributed a warming of 1.0°C to 2.0°C, other human drivers (principally aerosols) contributed a cooling of 0.0°C to 0.8°C, natural drivers changed global surface temperature by –0.1°C to +0.1°C, and internal variability changed it by –0.2°C to +0.2°C. It is *very likely* that well-mixed GHGs were the main driver of tropospheric warming since 1979.

The IPCC AR5 and AR6 statements provide likelihood assessments but not a confidence level. While the NCA5 claims with *very high confidence* that fossil fuels have unequivocally caused *all* global warming, the AR5 refers to “*more than half* of the observed warming” and the AR6 provides a more nuanced statement that relates to a *likely* range of warming contributed to by human drivers.

NCA5 Key message 2.2: “Hurricanes have been intensifying more rapidly since the 1980s (*high confidence*) and causing heavier rainfall and higher storm surges (*high confidence*).” No justification is provided in Chapter 2 for the *high confidence* conclusion on higher storm surges or hurricanes causing heavier precipitation. The Traceable Accounts section, Description of Confidence and Likelihood states:

Basic physical understanding and climate models both provide robust explanations for the links between climate change and observed changes in these extremes: this is why the authors also have *high confidence* that storms are delivering more rainfall and high confidence that storm surges are becoming higher.

In short, NCA5 provides no observational basis or published research for their *high confidence* assertions that hurricanes are causing heavier rainfall and higher storm surges; and does not meet its own standards for a *high confidence level*.

3.2 Overstating findings in underlying sources

Although we did not do a detailed audit of the NCA5’s use of source material, spot checks turned up evidence of a pattern of overstatement.

Chapter 2 page 11 reports on an increase in precipitation in some areas and attributes it to climate change:

Many eastern regions of the country are getting wetter (Figure 2.4). Average annual precipitation from 2002-2021 was 5%-15% higher relative to the 1901-1960 average in the central and eastern US, a trend attributable to climate change.

Note that this is a non-standard metric; we will discuss NCA5's inconsistent choices of time scales of analysis below. The claims were attributed to the following paper:

- Knutson, Thomas and Fanrong Zeng (2018) "Model Assessment of Observed Precipitation Trends over Land Regions: Detectable Human Influences and Possible Low Bias in Model Trends" *Journal of Climate* 31(12)
<https://journals.ametsoc.org/view/journals/clim/31/12/jcli-d-17-0672.1.xml>

But Knutson and Zeng did not say these things. They examined linear trends over 1901 – 2010, 1951 – 2010 and 1981 – 2010. They did not compare average rainfall over 2002 - 2021 to average rainfall over 1901 – 1960, indeed their study was published in 2018 so it could not have. With regard to 1981-2010 trends they noted stronger trends in some areas but cautioned that such changes are consistent with natural variability, and they did not claim attributable trends were observed over the United States:

Observed annual precipitation trends over the recent 30-yr period 1981–2010 (Fig. 5) have generally stronger magnitudes (in mm yr⁻¹ decade⁻¹) than observed trends for 1901–2010 or 1951–2010. This is as expected since trends over a shorter period have stronger potential for occurrence of pronounced temporary trends due to internal variability alone. Only 9% of the analyzed area has detectable and attributable anthropogenic influence (categories –3, –2, +2, +3), which represents less than one-third of the fractional areal coverage of such trends for 1901–2010 (29%). ... Eight percent of the analyzed area has attributable anthropogenic *increases* (categories +2, +3), including parts of eastern Europe, northern Asia, northern Australia/Maritime Continent, and tropical Africa.

Consider a 2nd example. NCA5 Chapter 2 page 18 states

There is robust evidence that human-caused warming has contributed to increases in the frequency and severity of the heaviest precipitation events across nearly 70% of the US.

This is attributed to two papers:

- Diffenbaugh, N.S., D. Singh, and J.S. Mankin, 2018: Unprecedented climate events: Historical changes, aspirational targets, and national commitments. *Science Advances*, 4 (2), 3354.
<https://doi.org/10.1126/sciadv.aao3354>
- Kirchmeier-Young, M.C. and X. Zhang, 2020: Human influence has intensified extreme precipitation in North America. *Proceedings of the National Academy of Sciences of the United States of America*, 117 (24), 13308-13313. <https://doi.org/10.1073/pnas.1921628117>

Diffenbaugh et al. presented ratios of observed occurrences of extreme events to simulated occurrence rates in CMIP6 models run with only natural forcings. They report that for 79% of the U.S. extreme rainfall event frequencies are currently higher than in model simulations, and the ratio of occurrences will rise under future warming simulations. This is not “robust” evidence of anthropogenic influence since it requires readers to assume that climate models provide accurate simulations of regional precipitation patterns, something which even the IPCC AR6 admits is uncertain (AR6 WGI SPM Box SPM 1.2, SPM Section C.1.3).

Kirchmeier-Young and Zhang looked at extreme 1- and 5-day events in North America and, using 3 GCMs, found “A signal of combined anthropogenic and natural external forcing can be detected in the intensification of extreme precipitation at the continental scale over North America. In some cases, this intensification can be attributed to human influence specifically.” However, they noted large differences among the three models in their simulated precipitation changes. Also, 2 of the 3 models failed to yield attribution for 5-day events for the North America mean, in other words the models disagreed on whether the observed changes were due to anthropogenic activity. Both cited references utilized the implausible RCP8.5 scenario and began their “historical” observational records only in 1961. Here again this is not “robust” evidence, it is suggestive but other studies have found natural variability predominant.

4 RELIANCE ON *Ad Hoc* TIME SCALES FOR TREND ANALYSIS

In CWG25 Chapter 6 we discussed the need to be careful regarding the choice of time scale when making claims about trends in extreme weather. We gave examples from analysis of river flooding (6.1), heatwaves (6.3) and extreme precipitation (6.4) to show how assertions about apparent trends based on short data sets fall apart when looking at longer versions of the same data sets. Here we elaborate on these examples to illustrate a general point that NCA5 made inconsistent and *ad hoc* choices about time scales of analysis, weakening the validity of their conclusions.

McKittrick and Christy (2019)³ showed that apparently significant positive trends in U.S. average and extreme precipitation over the NCA4 interval (1901 – 2016) disappeared on longer samples (extending back as far as the 1840s depending on location) or on a shorter interval coinciding with the final 40 years of the data then available (1978 – 2017).

In CWG Section 6.4 we presented analysis of updated data for the same locations and many more besides, in all cases finding both considerable regional heterogeneity and that trends detectable on one time scale are often not detected on longer or shorter time scales, which argues against simple attribution of changes to anthropogenic influences.

4.1 Average and Extreme Precipitation

Under Key Message 2.2 “Extreme Events Are Becoming More Frequent and Severe” (p. 2-16) NCA5 states (p. 2-18):

Rainfall is becoming more extreme

Since the 1950s, there has been an upward trend in heavy precipitation across the contiguous US. This increase is driven largely by more frequent precipitation extremes, with relatively smaller changes in their intensity.

NCA5 did not continue the NCA4 precedent of using the post-1901 interval as the time scale for its precipitation discussion, instead it refers to changes “since the 1950s”. Fig. 2.8 suggests 1958 as the start date. For the present report we have extended the CWG25 analysis even further to include 141 stations across the US in the Pacific Coast, Midwest, Northeast and Southeast regions. We provide details in Appendix XX; here we note merely that once again it is possible to find trends that support the NCA5 position, but they are not robust to selecting longer or shorter time scales of analysis. Data from 1950 to 2024 yields many indications of increased average and extreme precipitation at individual stations and region-wide averages. But when using the entire data set (back to the 1890s or earlier depending on location) or the later subset (1980 to 2024) the trends become smaller, in many cases they become statistically insignificant, and occasionally they change sign. Only in the Northeast region are the post-1950 trends robust to also focusing on the post-1980 interval.

The following is a more accurate summary of what U.S. data show.

³ McKittrick, R., and J.R. Christy (2019). Assessing changes in US regional precipitation on multiple time scales. *Journal of Hydrology*, 578, 124074. <https://doi.org/10.1016/j.jhydrol.2019.124074>

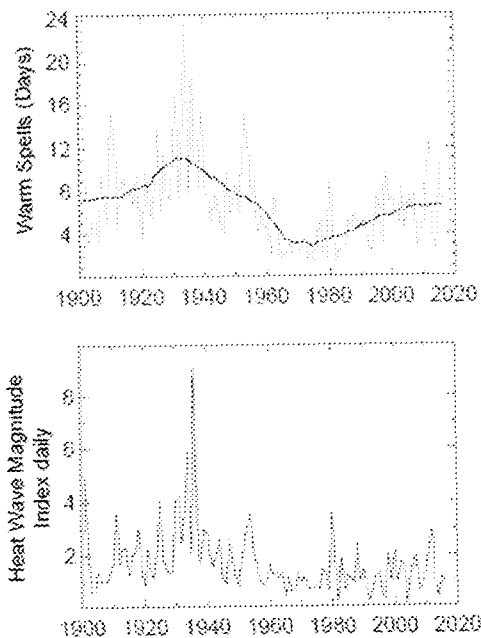
There are regionally-heterogenous changes in average and extreme precipitation. Positive trends in annual average rainfall and extreme events (defined either as the annual maximum or the number of exceedances of the 99th percentile value) are generally weak or non-existent when looking at samples exceeding 130 years in length. Significant trends can be found when beginning the sample in the 1950s although in most cases the trends weaken and become insignificant when looking at the post-1980 interval. This makes attribution to anthropogenic warming difficult.

4.2 Heatwaves

In contrast to NCA5, NCA4 examined heat extremes across the whole of the 20th century, pointing out that peak heat wave activity was reached in the 1930s and has decreased since then, and that recent increases are confined to areas west of the Rockies:

[The] warmest daily temperature of the year increased in some parts of the West over the past century, but there were decreases in almost all locations east of the Rocky Mountains. In fact, all eastern regions experienced a net decrease, most notably the Midwest (about 2.2°F [1.2°C]) and the Southeast (roughly 1.5°F [0.8°C]).

Since the mid-1960s, there has been only a very slight increase in the warmest daily temperature of the year (amidst large interannual variability). Heat waves (6-day periods with a maximum temperature above the 90th percentile for 1961–1990) increased in frequency until the mid-1930s, became considerably less common through the mid-1960s, and increased in frequency again thereafter. As with warm daily temperatures, heat wave magnitude reached a maximum in the 1930s. (NCA4 pp. 190-191)



U.S. Heat waves since 1900. Source: NCA4 Figure 6.4

Contrast this careful and factual language with NCA5 Key Message 2.2: “Extreme Events Are Becoming More frequent and Severe.” This blanket statement is followed by NCA5 Figure 2.7 reproduced below.

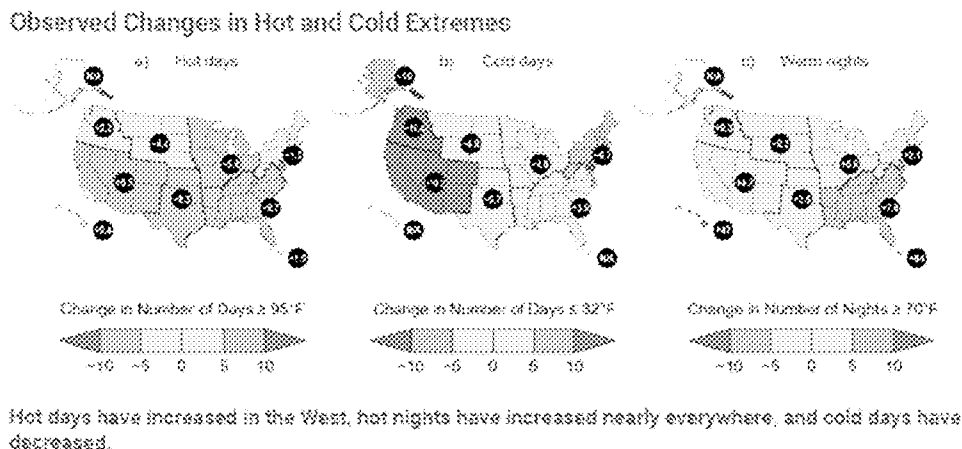


Figure 2.7. Over much of the country, the risk of warm nights has increased while the risk of cold days has decreased. The risk of hot days has also increased across the western US. This figure shows the observed change in the number of (a) hot days (days at or above 95°F), (b) cold days (days at or below 32°F), and (c) warm nights (nights at or above 70°F) over the period 2002–2021 relative to 1901–1960 (1951–1960 for Alaska and Hawaii and 1956–1980 for Puerto Rico). Data were not available for the US-Affiliated Pacific Islands and the US Virgin Islands. Figure credit: Project Drawdown, Washington State University Vancouver, NOAA NCIEI, and CIRES NC.

Close inspection shows that this Figure contradicts the NCA5 Key Message with respect to heatwaves and instead reinforces the position of the NCA4. The time scale of analysis for this Figure is stated as the number of hot days, cold days and warm nights (respectively in panels a—c) over the period 2002-2021 compared to 1901-1960. Presumably (though not stated in the caption) the counts are per year. Notwithstanding Key Message 2.2 the leftmost panel shows that over most of CONUS the number of extreme heat days has decreased in recent decades compared to the prior century.

The accompanying discussion in NCA5 becomes convoluted since it appears to be aimed at supporting the Key Message despite the contrary evidence. NCA5 chapter 2 elaborates on KM2.2 by saying (p. 16):

Observations show an increase in the severity, extent, and/or frequency of multiple types of extreme events. Heatwaves have become more common and severe in the West since the 1980s (*high confidence*).

But it does not mention the decline elsewhere. On the next page (p. 17) it says:

By some measures, the most extreme heatwaves on record in the United States occurred during the Dust Bowl era of the 1930s. ... Globally such heatwaves are becoming more frequent, and in recent decades the western United States has been following those trends.

Reference to a global trend seems to be an attempt to tie heatwaves to climate change, but then the obvious question, unaddressed by NCA5, is why only part of the U.S. follows it while most of the

country is trending in the opposite direction. These issues were addressed in CWG25 Ch6, demonstrating that the range and magnitude of extreme temperatures (10s of degrees) are driven more by natural variability than the small extra forcing from the enhanced concentrations of CO₂. The data shown in CWG25 shows that in terms of both (a) hot days ($\geq 95^{\circ}\text{F}$) and (b) number of days in heatwaves, the current decade is experiencing no more than was experienced 100 years ago. For example, in the 30-year period 1925-1954, representing only 23% of the 1899-2024 data record, the CONUS experienced 33% of the total heat wave days. The most recent 30-years experienced 24%, almost exactly that expected by chance. Thus, the NCA5 claim that “multiday heatwaves have become hotter, more frequent, larger, and longer lasting in recent decades,” is seen to be simply false when expanding the temporal and spatial domains to encompass all available data (Ch6 Fig. 6.3.6 CWG25).

The NCA5 then pointed to the dramatic Pacific Northwest heatwave of 2021. CWG Section 8.6.1 discussed this event in detail, reviewing the findings of multiple peer-reviewed studies that explained the unusual meteorological conditions giving rise to it were unrelated to climate change, a point omitted from the NCA5 discussion.

NCA5 finally turns to the declining heatwave trend in CONUS east of the Rockies but attempts to reframe it by focusing on urban warm spells.

[The] number of very hot days has actually decreased across the central and eastern regions due to summer cooling trends in the region (Figure 2.7; Ch. 22). This does not, however, mean the central and eastern US are not affected by heat. The impacts of extreme high temperatures are more severe if such conditions persist for several days, and overall, multiday heatwaves have become hotter, more frequent, larger, and longer lasting in recent decades. Across 50 large US cities, the US Global Change Research Program heatwave indicator (<https://www.globalchange.gov/indicators/heat-waves>) shows that the average number of heatwaves has doubled since the 1980s, and the length of the heatwave season has increased from about 40 days to about 70 days.

We discussed this issue in CWG25 Section 6.3. The Figure referenced by NCA5 uses an *ad hoc* definition of heat wave, namely two consecutive days with minimum nighttime temperatures above the 85th percentile, and an *ad hoc* time scale which begins in the 1960s, the coldest decade in the last century, thus suppressing any comparison to the 1930s. Nighttime temperatures in urban areas have gone up faster than daytime temperatures (which the NCA5 acknowledges), but this is a signature of urban heat island effects and is not a good metric of climate change. CWG25 noted as well that the occurrence of hot days ($\geq 95^{\circ}\text{F}$) has recently increased in the West, but declined in the remainder of the country, and in the nationwide average, since 1899.

5 INADEQUATE TRACEABLE ACCOUNTS

Starting with the NCA3, the NCA has included a section on Traceable Accounts at the end of each Chapter. This is the description from the NCA5:

Each chapter concludes with a section entitled Traceable Accounts, which provides information on the overall process used to develop the chapter as well as a separate Traceable Account section for each Key Message. These Traceable Accounts describe the supporting evidence behind each Key Message, the process and rationale authors used in reaching their conclusions, and the author team's expert assessment of the confidence in and, where applicable, likelihood of these conclusions. As such, Traceable Accounts provide information about the state of the science, document sources of uncertainty, identify research gaps, and allow traceability to data and resources.

The Traceable Accounts for each Chapter and Key Message includes the following sections:

- Description of Evidence Base
- Major Uncertainties and Research Gaps
- Description of Confidence and Likelihood

The Traceable Accounts are in principle an important factor in addressing the NCA's statutory requirement to discuss scientific uncertainties. Further, the Traceable Accounts can help satisfy the Executive Order for Restoring Gold Standard Science with regards to: reproducibility, transparency, communication of error and uncertainty, and skepticism of findings and assumptions. However, the execution of the Traceable Accounts is uneven, often superficial and noninformative in Chapters 2 and 3 (which were the only Chapters investigated here). Here is an example from Key Message 2.2: Extreme Events are Becoming More Frequent and Severe.

The Description of the Evidence Base consists of two paragraphs, with the first paragraph summarizing the findings and the second paragraph providing a generic description of the types of data that can be used for storms. Major Uncertainties and Research Gaps focuses on the uneven distribution across US populations due to differences in exposure and vulnerability. The only limitations in data referred to are the lack of a long-term record of lightning, and the lack of homogenized daily and hourly temperature data except from reanalysis products.

The most astonishing deficiency is in the Description of Confidence and Likelihood. One of the statements in Key Message 2.2 is:

Hurricanes have been intensifying more rapidly since the 1980s (high confidence) and causing heavier rainfall and higher storm surges (high confidence).

The Description of Confidence and Likelihood includes the following statement:

Basic physical understanding and climate models both provide robust explanations for the links between climate change and observed changes in these extremes: this is why the authors also have high confidence that storms are delivering more rainfall and high confidence that storm surges are becoming higher.

No reference to journal publications or a specific data set is made in the Chapter regarding hurricane induced precipitation or storm surge to support this *high confidence* conclusion.

With regards to Chapter 3, there are some substantial inconsistencies between the Traceable Accounts for the different Key Findings:

Key Message 3-1: Human activities have caused global warming.

Confidence and Likelihood: “There is *very high confidence* that emissions of GHGs from human activities, fossil fuel use in particular, have *unequivocally* caused all global warming observed over the industrial era. There is also *very high confidence* that changes in natural climate drivers have had globally small and regionally variable long-term effects over this period.”

The Uncertainties section only addresses uncertainties in radiative forcing of greenhouse gases. By contrast, consider Key Message 3-4: “Humans are changing Earth System processes.” The Traceability Analysis in this section contains arguably the most scientifically credible text in the entire Chapter. From Description of Evidence Base:

In the last decade, there has been increasing recognition of the role of regional-scale natural variability in the past and future evolution of climate, as well as the fact that regional natural variability signals can be competitive with forced anthropogenic signals.

From Major Uncertainties and Research Gaps:

For example, the true natural variability of the climate system on decadal to centennial timescales could be larger than what we estimate from GCMs, which would further increase the irreducible uncertainty stemming from natural variability.

As part of the Traceable Account: “Each figure and some tables are accompanied by a metadata survey, which can be accessed in the online version of the report by clicking on the eyeball icon above the figure or table (see the table below for explanations of additional icons used throughout the report). The metadata survey describes data sources, figure or table development methods, copyright information, and other important documentation.” Upon clicking on the eyeball icon above a particular figure, a Contact US email appears, addressed to the USGCRP. No attempt was made to send a email to elicit the Metadata information, but it is clear that this information is not readily accessible online.

In summary, the Traceable Analyses examined here, with few exceptions, fail to meet the stated objectives set forward by the NCA.

6 OVEREMPHASIS ON EXTREME SCENARIOS

To respond to the GCRA mandate to “project major trends for the subsequent 25 to 100 years,” the NCA relies on projections of future climate change based on estimates of future emissions (the so-called SSP scenarios) and/or specified levels of radiative forcing (the RCP scenarios). For the most part, NCA5 uses scenarios developed for the IPCC Assessment Reports.

In CWG Section 3.2.1 we presented a critical assessment of past and current IPCC scenario envelopes, showing that they have tended to overshoot observed emissions. The IPCC AR6 published in 2021 stated that “The likelihood of high-emission scenarios like RCP8.5 and SSP5-8.5 is considered low in light of recent energy sector developments.” In 2021, UN Climate Negotiators (COP) stopped using scenarios above 4.5. NCA5 makes the following observations about the scenarios they use:

“NCA5 authors were advised to assess the full range of scenarios available.” (Front Matter)

“Scenarios of future emissions and land-use change are developed as plausible alternatives, but no relative likelihood is attached to them. Some recent studies, however, have argued that the highest scenario, SSP5-8.5, is no longer plausible without a reversal of current trends in the adoption of renewables and energy efficiency.” (Key Message 3.3 Traceable Analysis)

Despite acknowledging the issue the NCA5 otherwise ignored the problem. A keyword search of the NCA5 of mentions of RCP/SSP scenarios finds over 50% referred to the extreme emissions scenarios RCP8.5/SSP5-8.5. Further, 10 figures *only* included the 8.5 scenarios: 5.2, 6.9, 7.4, 11.3, 14.6, 22.13, 22.19, 27.9, 29.13.

The problem of relying on extreme scenarios is particularly acute for NCA5’s sea level rise projections. The sea level rise scenarios used in the NCA5 do not relate directly to the SSP emissions scenarios, but to specified amounts of sea level rise by 2100, whereby Low relates to 0.3 m (0.98 feet), Intermediate-Low relates to 0.5 m (1.64 feet), Intermediate relates to 1.0 m (3.28 feet), Intermediate-High relates to 1.5 m (4.92 feet), and High relates to 2.0 m (6.56 feet). (Table 4 of Guide to Using this Report).

Table 4. Descriptive Terms for Common Sea Level Rise Scenarios Used in NCA5

Future global mean sea level rise and sea level rise along United States coastline are shown for five scenarios in feet (and meters), relative to a 2000 baseline. The US values shown in the right half of the table are averaged across the US coastal regions, including the contiguous US, Alaska, Hawaii and the US-Affiliated Pacific Islands, and the US Caribbean. The national values shown in the table differ substantially from regional values. For example, sea level rise is higher in the Gulf Coast and lower or even negative in some parts of Alaska. In the next 10 years (2020–2030), sea level along the contiguous US coasts is expected to rise 0.92 feet (0.28 m), the same amount of sea level rise observed over the last 100 years (1920–2020). See Chapter 9 for regional sea level information. Adapted from Sweet et al. 2022.¹

Sea Level Rise Scenario Descriptor	Global Mean Sea Level			United States		
	2050	2100	2150	2050	2100	2150
Low	0.49 (0.15)	0.98 (0.3)	1.31 (0.4)	0.59 (0.18)	0.98 (0.3)	1.64 (0.5)
Intermediate-Low	0.66 (0.20)	1.64 (0.5)	2.62 (0.8)	0.75 (0.23)	1.64 (0.5)	2.95 (0.9)
Intermediate	0.92 (0.28)	3.28 (1.0)	6.23 (1.9)	0.89 (0.27)	3.28 (1.0)	6.89 (2.1)
Intermediate-High	1.21 (0.37)	4.92 (1.5)	8.86 (2.7)	1.12 (0.34)	4.92 (1.5)	8.86 (2.7)
High	1.41 (0.43)	6.56 (2.0)	12.14 (3.7)	1.38 (0.42)	6.56 (2.0)	12.46 (3.8)

CAPTION NEEDED

The text following is Judy's latest edit

Considering only projections representing processes quantified with at least medium confidence, the IPCC AR6 assessed global mean sea level projections for 2100 to fall between 0.2 and 1.6 m (5th—95th percentile range). Nevertheless, the range of sea level rise scenarios considered by the NCA5 extends to 2.0 m. Further, the NCA5 neglects to include plausible lower scenarios, such as 0.2 m cited by the IPCC, which also corresponds to the average rate of sea level rise over the past century.

With regards to actual predictions of sea level rise, Chapter 9 of the NCA states: “Under a range of potential global warming levels, average sea level along US coastlines is *likely* to be between 12 and 20 inches above 2000 sea levels in 2050.” These values of sea level rise encompass the Intermediate scenario to values slightly higher than the High scenario from NCA5 Table 4 shown above.

Global sea level rise projections to 2050 relative to a 2000 baseline can be evaluated with respect to the observed global sea level rise from 2000-2024, which is approximately 3.39 inches (0.28 feet). <https://www.climate.gov/news-features/understanding-climate/climate-change-global-sea-level> Hence NCA5 is projecting values of sea level rise between 2025 and 2050 that are 3.5 to 5.8 times the rate observed during 2000-2024.

Chapter 9 further states: “Looking toward the future, an 11 inch (28 cm) average rise along the contiguous US coastline is expected by 2050 (relative to 2020), with a *likely* range of 9-13 inches.” With regards to confidence levels, NCA5 Chapter 9 Traceable Accounts states: “There is *high confidence* and it is *likely* that sea levels will rise about 11 inches (likely range of about 9–13 inches) between 2020 and 2050”

In summary, the NCA5 presents future sea level rise scenarios that are not directly relatable either to SSP/RCP emissions scenarios or Global Warming Levels. The NCA5 scenarios include some that are higher than the 95th percentile for the extreme emissions scenario RCP8.5 that include hypothesized ice sheet processes for which there is low confidence. Projections to 2050 require rates of sea level rise from 2025 to 2050 that are more than three times the rate observed during 2020-2024. Further, the NCA5 ascribes *high confidence* to these sea level rise projections.

In summary, the NCA5 inclusion, and even the focus, on implausible extreme emissions scenarios supports projections of alarming impacts that are very unlikely to be driven by anthropogenic warming.

7 BIASED SELECTION OF REFERENCES

THIS IS WHERE THE RP JR example should go.

8 SUMMARY: EVALUATION OF THE NCA5

8.1 Inadequate NASEM Review

The NASEM Review failed to raise the issues we have discussed herein. Much of it focused on social and policy issues (e.g., Comments on Equity and Justice), rather than on the underlying science. In our assessment NASEM failed to apply the serious rigor one would expect. A few extracted comments from it will illustrate. Note that NASEM review comments are included here in blue font for reference. NASEM praised Chapter 2, saying:

The chapter [2] meets the requirements of Section 106 of the GCRA.

Yet contrary to the requirements of Section 106 the NCA5 did not discuss natural variability let alone assess the full climate record available for quantifying natural variability. Chapter 2 actually minimizes natural variability by claiming (unsubstantiated) skill in attributing recent extremes to human causes. For example NCA5's Chapter 2 Introduction states,

"...recent advances in attribution science (KM 3.3) mean that the role of climate change in some extreme events can now be quantified in real time. For example, climate change made the record-breaking Pacific Northwest heatwave of June 2021 2° to 4°F hotter, and in 2017 ..."

CWG25 reviews the expert literature demonstrating that this particular event would have happened with or without climate change and that for the CONUS, hot extremes are no more frequent now than they were in the past. NASEM did not challenge the unsubstantiated attribution claims in the NCA5.

Notwithstanding NASEM's claim that the Chapter complies with Section 106 of the GCRA it then acknowledged the absence of discussion of natural variability:

...the discussion and references regarding the role of natural climate variability and its regional differences are missing.

While a nod to natural variability is occasionally found in NCA5, it is usually followed by a "however" to emphasize human influence. One example is the statement just before the claim mentioned above pertaining to extreme event attribution: "There has always been extreme weather, which occurs even in an unchanged climate due to the natural variability of the Earth system. However, recent advances in attribution science (KM 3.3) mean that the role of climate change in some extreme events can now be quantified in real time..."

We pointed out that the evidence regarding heatwaves directly contradicts Key Message 2.2. NASEM did not mention this, instead it focused on a somewhat esoteric issue of terminology:

"Extreme Events Are Becoming More Frequent and Severe."

Key Message 2.2 is another generally well written key message. However, while the title of this key message includes the word "risk," the key message is exclusively about hazard. The Committee suggests rewriting the key message title to more accurately reflect the discussion on hazards.

The NASEM review appears to accept the NCA5's use of short data records because it makes no critical remarks about the failure to assess long time series, except for its observation that the use of short records makes the omission of natural variability that much more of a problem:

It is also important to point out that the influence of natural climate variability becomes particularly strong when the climate trend is computed based on short periods of time or small geographic areas.

This comment was largely ignored in the NCA5 final text.

8.2 Pertinent aspects when evaluating NCA5 in light of statutory requirements

- not our remit to make a ruling but here are aspects to consider in light of statutory requirements

8.3 Evaluation from the perspective of expert users of the report

- we have deep knowledge of the topics surveyed by the NCA5 authors
- we do not have confidence that the report was balanced and comprehensive
- we can point to many specific instances in which the report did not exhibit an appropriate level of quality or integrity as a scientific document
- we have reason to believe the whole process, from author selection to handling of expert reviews, was biased towards reinforcing foregone conclusions and alarmist messaging

8.4 Evaluation from the perspective of citizens interested in good policymaking

- Public concerns about climate change are valid, as are concerns about cost of living, economic growth, employment, etc.
- We share the general concern that elected officials and those who serve them have the best information available when making important decisions around energy and climate policy
- NCA5 was a missed opportunity: it could have been a valuable input to that process but it did not turn out that way
- consequently its usage is unlikely to lead to better decisions and would more likely increase the error rate in policy formation and we recommend it not be used for policymaking purposes.

APPENDIXES

APPENDIX 1: Seth's letter on statutory requirements for NCA5

APPENDIX 2: Analysis of 141 U.S. Longterm Daily Precipitation Records.

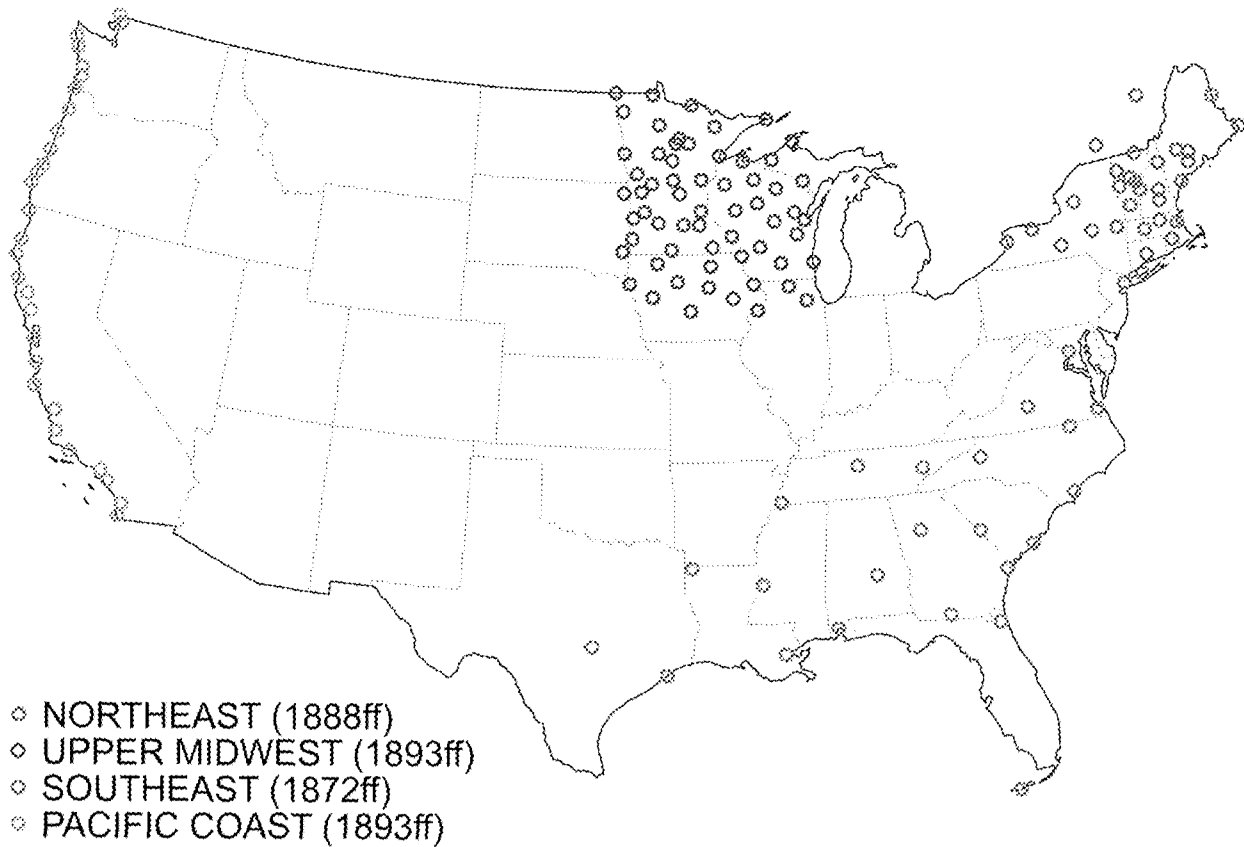


Figure. Stations used in the following analyses.

Table codes: (-) neg insignificant, -- neg significant, (+) pos insignificant, ++ pos significant.

Column 1: Measure

Column 2: Number of stations in that region

Column 3: Count of stations exhibiting a significant positive trend

Column 3: Count of stations exhibiting a significant negative trend

Column 5: Characteristic of region-wide trend

PACIFIC COAST

Since 1893:

	No. stns	+ trends	- trends	region
1-day average	29	0	1	(-)
2-day average	29	0	1	(-)
Avg on non-zero days	29	0	9	--
Variability	29	1	0	(+)
Annual max	29	2	1	(+)

Number of 99 th pct exceedances	29	1	0	(-)
--	----	---	---	-----

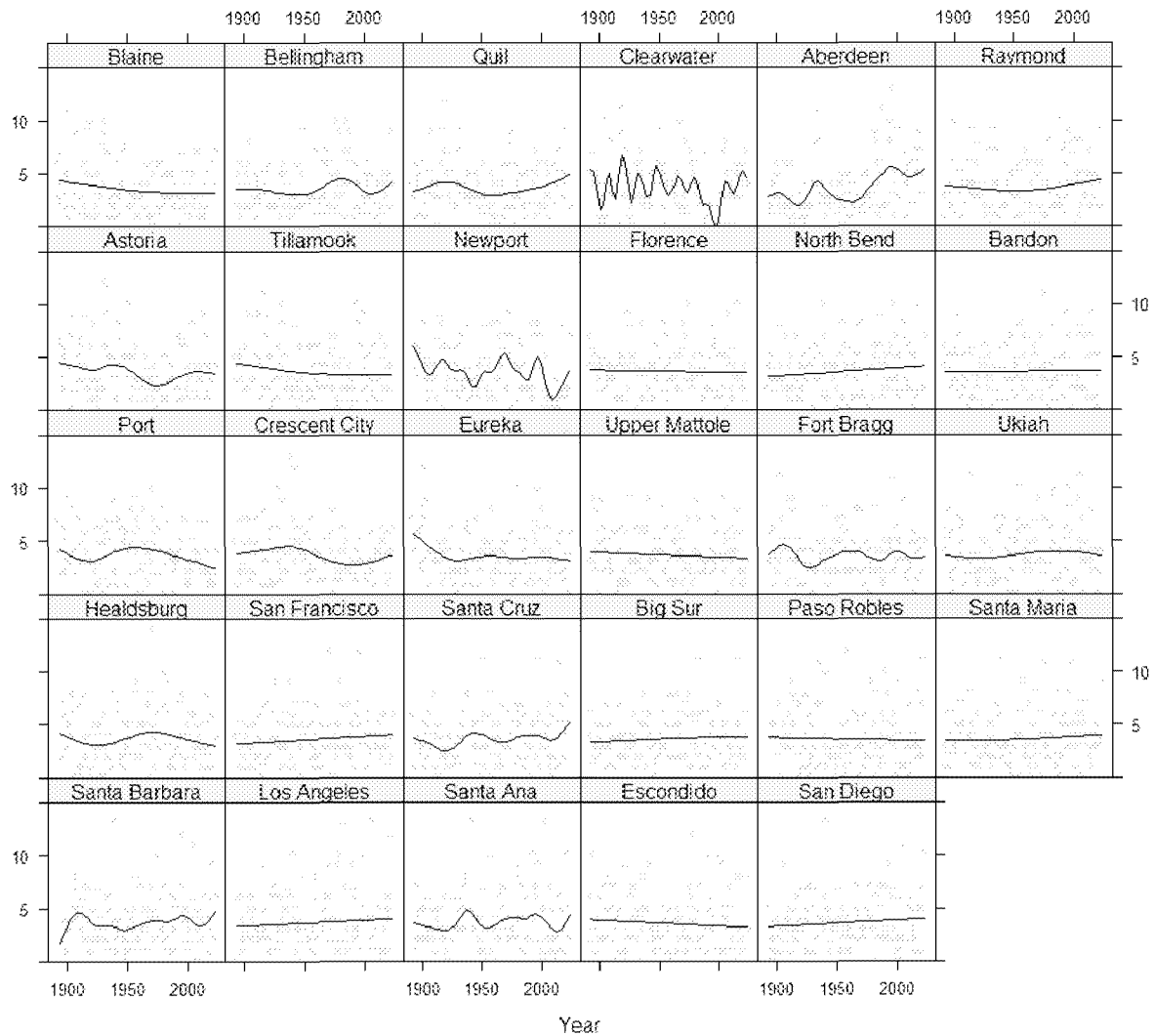
Since 1950:

	No. stns	+ trends	- trends	region
1-day average	29	0	1	(-)
2-day average	29	0	1	(-)
Avg on non-zero days	29	0	4	(-)
Variability	29	2	3	(-)
Annual max	29	6	3	(-)
Number of 99 th pct exceedances	29	2	1	(-)

Since 1980:

	No. stns	+ trends	- trends	region
1-day average	29	0	0	(-)
2-day average	29	0	0	(-)
Avg on non-zero days	29	0	1	(-)
Variability	29	0	0	(-)
Annual max	29	2	1	(-)
Number of 99 th pct exceedances	29	0	0	(+)

Annual No. 99th Percentile Exceedances PC 1893-2024



SOUTHEAST

Since 1873:

	No. stns	+ trends	- trends	region
1-day average	24	1	1	(+)
2-day average	24	1	1	(+)
Avg on non-zero days	24	7	2	(+)
Variability	24	1	0	(+)
Annual max	24	2	0	(+)
Number of 99 th pct exceedances	24	5	0	(+)

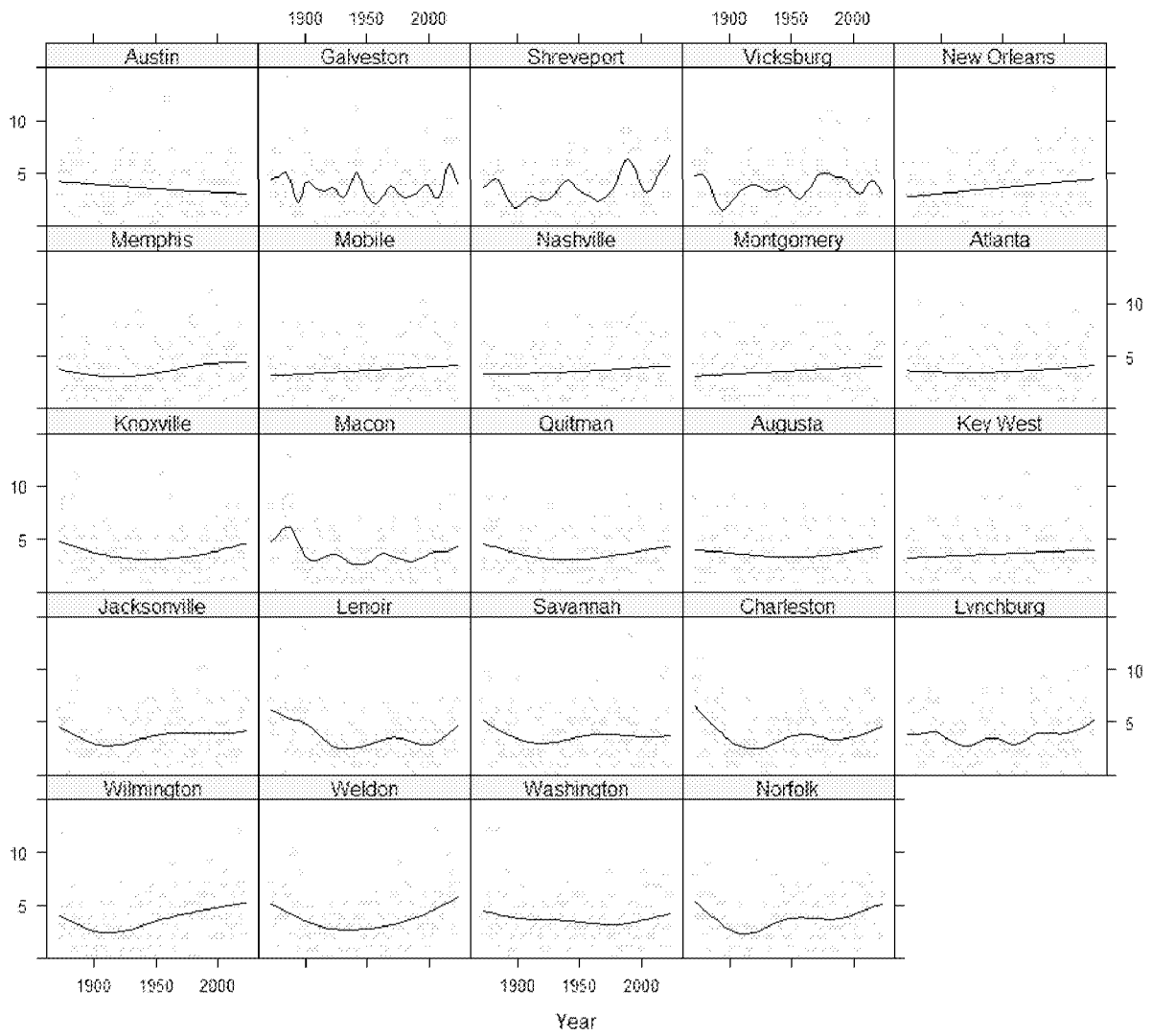
Since 1950:

	No. stns	+ trends	- trends	region
1-day average	24	5	0	++
2-day average	24	5	0	++
Avg on non-zero days	24	5	1	++
Variability	24	6	0	++
Annual max	24	4	0	++
Number of 99 th pct exceedances	24	4	0	(+)

Since 1980:

	No. stns	+ trends	- trends	region
1-day average	24	5	0	(+)
2-day average	24	5	0	(+)
Avg on non-zero days	24	5	1	(+)
Variability	24	3	0	(+)
Annual max	24	4	0	(+)
Number of 99 th pct exceedances	24	4	0	(+)

Annual No. 99th Percentile Exceedances SE 1873-2024



MIDWEST

Since 1893:

	No. stns	+ trends	- trends	region
1-day average	61	23	0	++
2-day average	61	23	0	++
Avg on non-zero days	61	2	12	(+)
Variability	61	12	0	++
Annual max	61	9	0	(+)
Number of 99 th pct exceedances	61	10	0	(+)

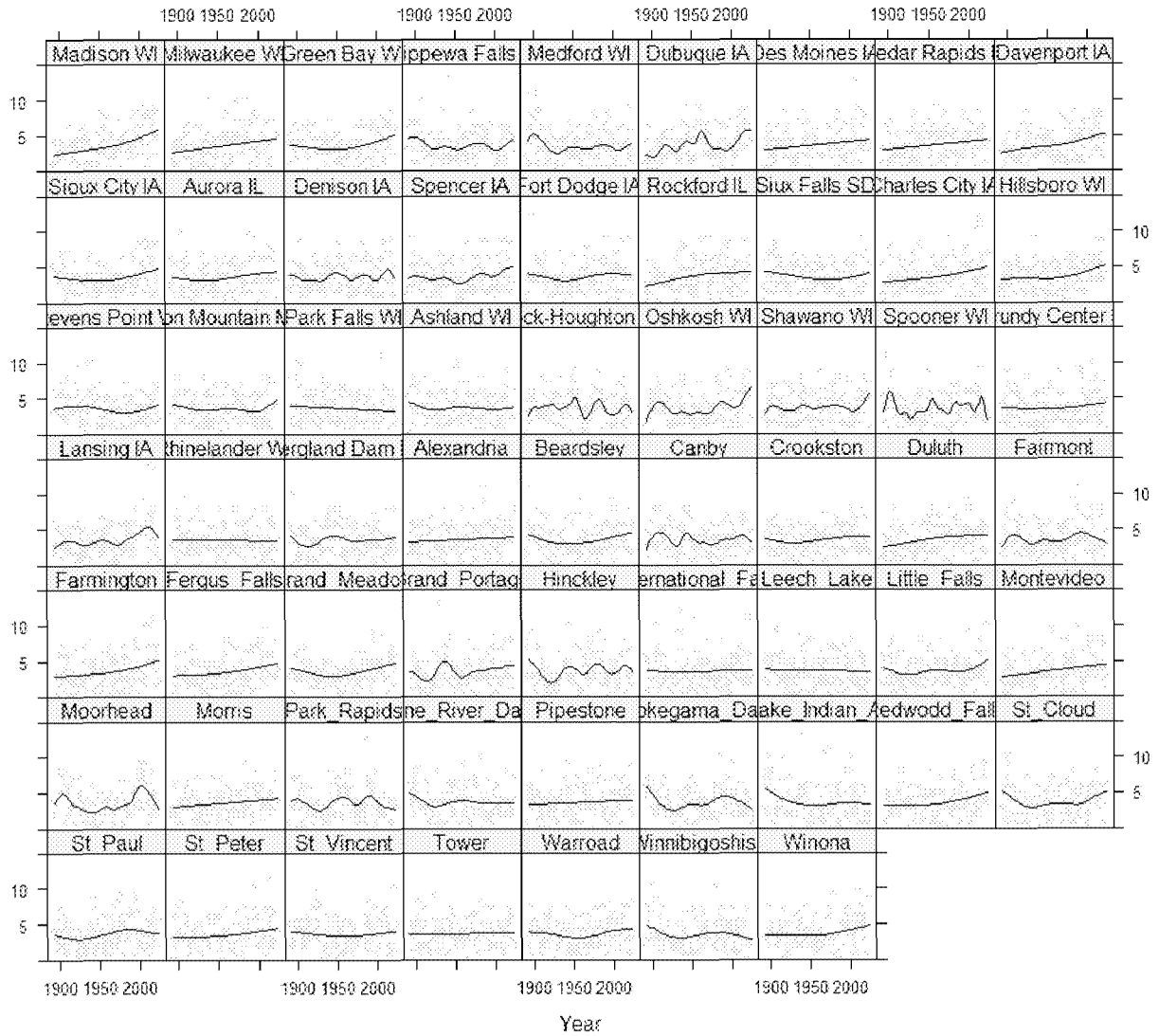
Since 1950:

	No. stns	+ trends	- trends	region
1-day average	61	28	2	++
2-day average	61	28	2	++
Avg on non-zero days	61	11	1	++
Variability	61	16	0	(+)
Annual max	61	8	0	(+)
Number of 99 th pct exceedances	61	19	0	++

Since 1980:

	No. stns	+ trends	- trends	region
1-day average	61	6	1	(+)
2-day average	61	6	1	(+)
Avg on non-zero days	61	8	2	(+)
Variability	61	5	1	(+)
Annual max	61	0	1	(+)
Number of 99 th pct exceedances	61	5	3	(-)

Annual No. 99th Percentile Exceedances MW 1893-2024



NORTHEAST

Since 1888:

	No. stns	+ trends	- trends	region
1-day average	27	12	0	++
2-day average	27	12	0	++
Avg on non-zero days	27	7	1	(+)
Variability	27	4	0	(+)
Annual max	27	3	0	(-)
Number of 99 th pct exceedances	27	5	0	(+)

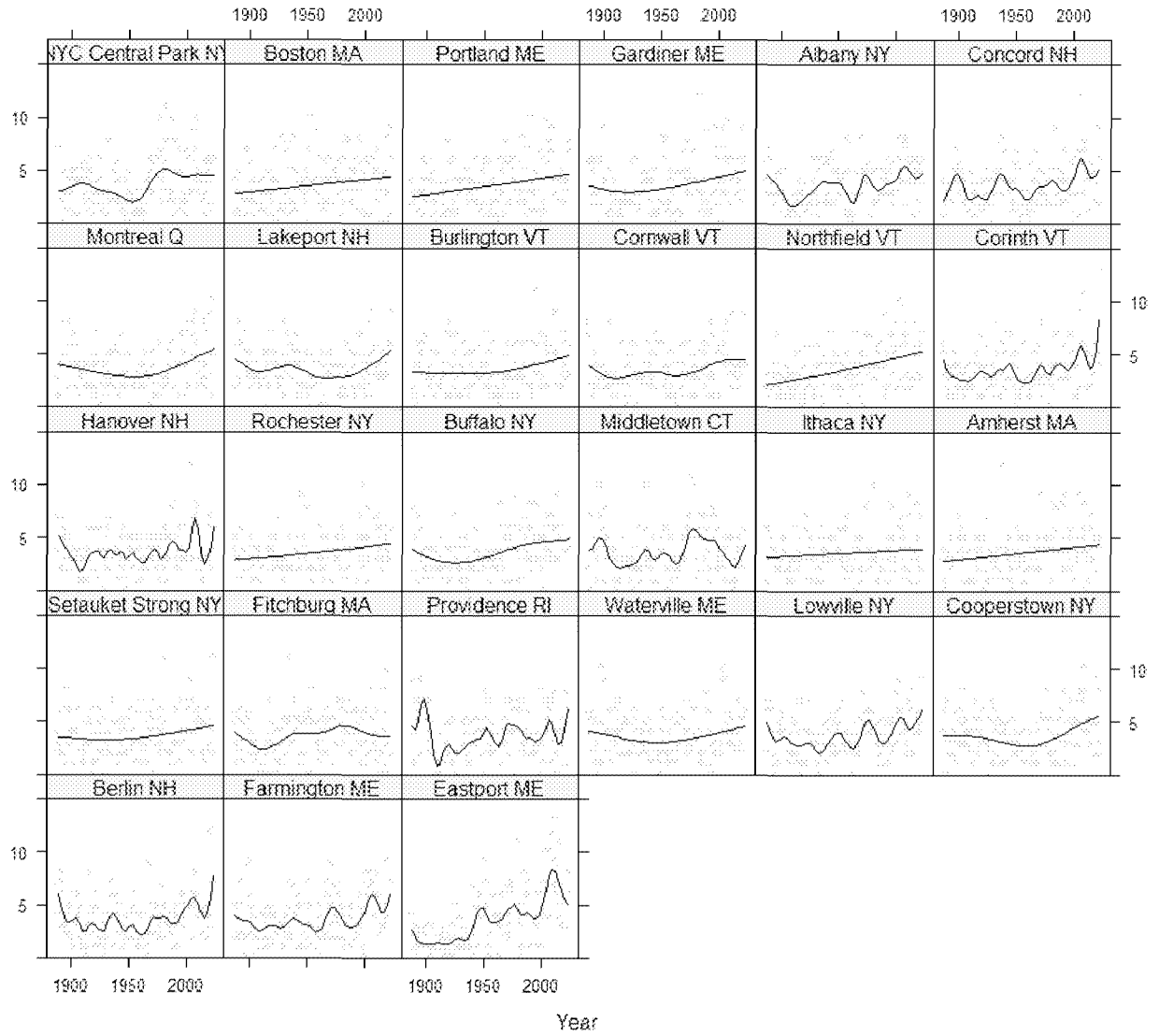
Since 1950:

	No. stns	+ trends	- trends	region
1-day average	27	12	0	++
2-day average	27	12	0	++
Avg on non-zero days	27	7	1	(+)
Variability	27	4	0	(+)
Annual max	27	3	0	(-)
Number of 99 th pct exceedances	27	5	0	++

Since 1980:

	No. stns	+ trends	- trends	region
1-day average	27	10	1	++
2-day average	27	10	1	++
Avg on non-zero days	27	6	0	(+)
Variability	27	2	0	(+)
Annual max	27	1	0	(+)
Number of 99 th pct exceedances	27	1	1	++

Annual No. 99th Percentile Exceedances NE 1888-2024



From: Steven Koonin <steven.koonin@gmail.com>
Sent: Wednesday, June 11, 2025 8:40 PM
To: 'Ross McKitrick'; 'Judith Curry'; 'Roy W. Spencer'; 'John Christy'; 'Steven Koonin'; 'Travis Fisher'; 'Josh Loucks'
Subject: RE: JUne 11 draft
Attachments: NCA5.Review.[SK].June11.docx

Oh, we're doing double work.

The attached is my latest integrated version, incorporating almost all of the changes Ross sent out yesterday, and my going through all of the sections.

We somehow need to reconcile these two.

SEK

From: Ross McKitrick <ross.mckitrick@gmail.com>
Sent: Wednesday, June 11, 2025 6:48 PM
To: Judith Curry <curry.judith@gmail.com>; Roy W. Spencer <roywspencer@hotmail.com>; John Christy <climateman60@gmail.com>; Steven Koonin <steven.koonin@googlemail.com>; Travis Fisher <travis.scott.fisher@gmail.com>; Josh Loucks <loucksj14@gmail.com>
Subject: JUne 11 draft

The attached incorporates all of Judy's suggestions including deletions and John's edits of Sct 4.2. I also dealt with Steve's various comments in the opening section as best I could. Did some additional editing, including adding in Roy's word search data. John you had suggested some additional text for the NCA4 magic ratio diagram but I think the example works best if we keep the writeup as simple as possible.

I am not sure Chapter 7 (biased references) is needed unless someone plans to write it up. I moved the discussion of the NASEM review to Ch 8. Do we have more material for that? Also I took out the review example from RPJr since I don't think we have documentation for it. it is a good one to keep in reserve though in case people want to wave peer review at us.

Review of the Fifth National Climate Assessment

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1 INTRODUCTION

1.1 About this Report

This report responds to a request from OSTP Director Michael Kratsios (reproduced in Appendix 1) that we assess the suitability of the Fifth National Climate Assessment for informing climate and energy policies.

To conduct our assessment, we reviewed NCA5 itself, the NASEM review of the Third Order Draft and the USGCRP responses to that review. We have drawn upon our long experience working on advisory reports, including for the NASEM, IPCC and other organizations, as writers, reviewers and study leaders.

We find that NCA5 should not be relied on for policy making as it is an incomplete and misleading picture of our understanding of the changing climate and the risks it poses to the nation. NCA5 was selective and incomplete in its survey of climate science as of its publication date in 2023 and has become even more so in the years since. We have reviewed many key scientific developments in a separate report to Energy Secretary Wright (Climate Working Group 2025, herein denoted “CWG25”). The overall effect of NCA5’s biases and omissions is an excessively dire picture of climate risk.

Our report begins with background on the National Climate Assessments. We then discuss the standards by which we have assessed NCA5, followed by specific deficiencies that we have identified.

1.2 About the National Climate Assessments

The U.S. Global Change Research Program (USGCRP) was established by Presidential Initiative in 1989 and mandated by Congress in the Global Change Research Act (GCRA) of 1990 to develop and coordinate “a comprehensive and integrated United States research program which will assist the Nation and the world to understand, assess, predict, and respond to human-induced and natural processes of global change.”

The National Climate Assessment (NCA) Reports evolved from the GCRA requirement to

Prepare and submit to the President and the Congress an assessment which (1) integrates, evaluates, and interprets the findings of the Program and discusses the scientific uncertainties associated with such findings; (2) analyzes the effects of global change on the natural environment, agriculture, energy production and use, land and water resources, transportation, human health and welfare, human social systems, and biological diversity; and (3) analyzes current trends in global change, both human-induced and natural, and projects major trends for the subsequent 25 to 100 years.

The five NCA Reports to date have interpreted this mandate in different ways:

- NCA1 (2000) was a multidisciplinary effort to study and portray in regional detail the potential effects of human-induced global warming on the United States.
- NCA2 (2009) was a relatively short report that not only focused on the potential consequences of climate change but also sought to identify potential adaptation measures and identify the highest priorities for future research.

- NCA3 (2014) was an expanded effort that continued along the lines of NCA2, and was distinguished by a comprehensive review process, including a review by the National Academy of Sciences.
- NCA4 (2017/2018) was an expanded effort published in two volumes: I Climate Science Special Report, and II Impacts, Risk, and Adaptation in the United States. This was the first NCA report to devote significant effort to assessing climate science. NCA4 introduced a traceability analysis for each key finding, including a cursory description of uncertainties.
- NCA5 (2023) returned to a single volume format, reducing discussion of climate science to a cursory two chapters, with continuing with a focus on regional and sectoral impacts of climate change. NCA5 expanded its remit to topics that are arguably outside the purview of the USGCRP, focusing on “Climate Action” and policy recommendations with a social justice emphasis. NCA5’s self-description is reproduced as Appendix II.

These successive interpretations of the NCA are poorly aligned with the GCRA’s statutory requirements. Only NCA4 gives serious consideration to climate science, which receives the great majority of USGCRP funding, and even then misrepresents some important points (see Section 1.4 below). Natural climate variability is essentially dismissed as unimportant in NCA4 and barely mentioned in NCA5 in most contexts, despite the mandate to include both human-caused and natural climate change. Most significantly, NCA5 has redirected the focus away from climate science and even the hazard elements of impacts, towards evaluation of societal vulnerabilities and advocacy for particular policy options, especially wind and solar power. The cover image for the NCA5 Report is the installation of a solar panel.

1.3 Standards for Assessing NCA Products

In Appendix 2 we include a letter of guidance from the Office of General Counsel, U.S. Department of Energy, summarizing the extent of statutory requirements governing USGCRP work products in general and NCA products in particular.

We can summarize the standards applicable to the NCA as follows:

- details.

Beyond the statutory requirements we draw attention to two other pertinent standards. President Trump’s executive order of May 23, 2025, “[Restoring Gold Standard Science](#)” enumerates some of the characteristics of good science:

- i. reproducible;
- ii. transparent;
- iii. communicative of error and uncertainty;
- iv. collaborative and interdisciplinary;
- v. skeptical of its findings and assumptions;
- vi. structured for falsifiability of hypotheses;
- vii. subject to unbiased peer review;
- viii. accepting of negative results as positive outcomes; and
- ix. without conflicts of interest.

Although these should be self-evident to those trained in science, it is surprising that some have found them controversial.

There are other desiderata for scientific reports that will be highly influential on climate policymaking. Among them are statements about the strength of climate knowledge. The IPCC's approach is based on judgment of the available evidence and agreement among experts. More sophisticated knowledge characterizations for risk management include: REFERENCE AVEN

- The degree to which the assumptions made are reasonable/realistic based on background knowledge—concern about the focus on implausible emissions scenarios RCP8.5/SSP5–8.5
- The degree to which data/information exists and are reliable and relevant—the historical and paleo database is inadequate for a complete characterization of natural climate variability on multi-decadal to millennial time scales
- The degree to which there is disagreement among experts (including those from different environments or academic fields)—attempts to suppress disagreement and alternative perspectives among experts
- The degree to which the phenomena involved are understood and accurate models exist—concerns about the fidelity and utility of climate models
- The degree to which the knowledge has been thoroughly examined with respect to unknown knowns and—neglect of the unknown knowns associated with natural climate variability

Good climate and energy policies will balance the risks and benefits of a changing climate against the world's growing demand for reliable and affordable energy. To strike that balance, policymakers must understand at least two complex and nuanced topics: the certainties and uncertainties of climate science and the technoeconomic realities of energy systems. Experts in those subjects have a unique responsibility to communicate their understanding to non-experts clearly, completely, and without bias.

Expertise in energy systems resides largely in the private sector, where it is essential to providing the reliable and affordable energy services that are the lifeblood of society. Understanding is therefore continually refined and tested by the discipline of the marketplace. In contrast, climate science expertise is found largely in the non-profit realm of universities and government laboratories and so has a more academic character.

Because climate is at the core of human existence, it can engender passion and emotion. Indeed, some younger climate scientists have gone into the field to “save the planet.” So it isn't surprising that objectivity can suffer when climate scientists communicate their understanding to non-experts. Further, the field of climate science has been politicized by NetZero mandates. This lack of objectivity usurps the public's right to make informed choices and undermines their confidence in the scientific enterprise.

Philip Handler, President of the National Academy of Sciences, identified the problem in a 1980 editorial that resonates eerily four decades later:

Difficulty arises in the scientific community from confusion of the role of scientist *qua* scientist with that of scientist as citizen, confusion of the ethical code of the scientist with the obligation of the citizen, blurring the distinction between intrinsically scientific and intrinsically political questions. When scientists fail to recognize these boundaries, their own ideological beliefs, usually unspoken, easily becloud seemingly scientific debate.

1.4 When Peer-Review Fails: An Example from NCA4

The peer-review of reports from the IPCC USGCRP is not a silver bullet that guarantees quality. The peer review process for these reports differs in some important respects from traditional peer review in academic journals. First, NCA reviewers self-select on a volunteer basis whether to provide comments and what parts of the report to read, whereas the editors of academic journals recruit reviewers and assign them to specific papers. There is no guarantee that any particular section of an NCA report was reviewed by anyone, let alone by someone with a different perspective than the authors. This is a problem with NCA and IPCC reports since over the years many potential reviewers have given up making the effort, because their input has systematically been ignored. Second, NCA authors have near complete authority whether to accept or reject review comments. Here, for example, is how a review comment critical of a section of the NCA5 draft was handled by the authors:

REVIEWER COMMENT

Tropical Cyclones/hurricanes have not increased (Klotzbach, P.J., Bowen, S.G., Pielke, R. and Bell, M., 2018. Continental US hurricane landfall frequency and associated damage: Observations and future risks. Bulletin of the American Meteorological Society, 99(7), pp.1359-1376., Pielke, R., 2021. Economic Anormalisation, A def disaster losses 1998, A 2020: A literature review and assessment. Environmental Hazards, 20(2), pp.93-111.)

US NCA RESPONSE

Thank you for your comment.

This comment is inconsistent with the author team's thorough assessment of the science.

By contrast, the editor of an academic journal mandates the authors' response and the reviewer gets to assess its adequacy. And third, the work of an NCA chapter author team is guaranteed to be published, whereas academic journals routinely reject papers that do not pass review.

These points are important because some readers might dismiss any criticism of NCA products out of hand on the grounds that the reports were "peer reviewed". But the test of a report is whether its contents are a valid representation of the available evidence. Here we give an example in which NCA4 gave prominence to a figure that completely misrepresented the underlying data and which evaded peer review to do so. Further details can be found in Koonin (2024).

As shown in CWG25 Section 6.3, the number of heat extremes in the U.S. peaked in the 1930s and has declined ever since. Taking cold and hot extremes together the U.S. climate has become more moderate over time. Yet NCA4's Part I (Climate Science Special Report, CCSR) says (prominently and with *Very High Confidence*) on Page 19 of the Executive Summary:

There have been marked changes in temperature extremes across the contiguous United States. The number of high temperature records set in the past two decades far exceeds the number of low temperature records.

and offers this figure in support:

Record Warm Daily Temperatures Are Occurring More Often

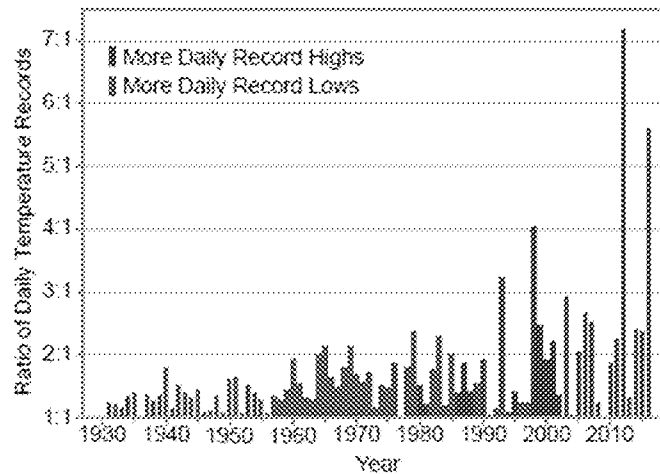
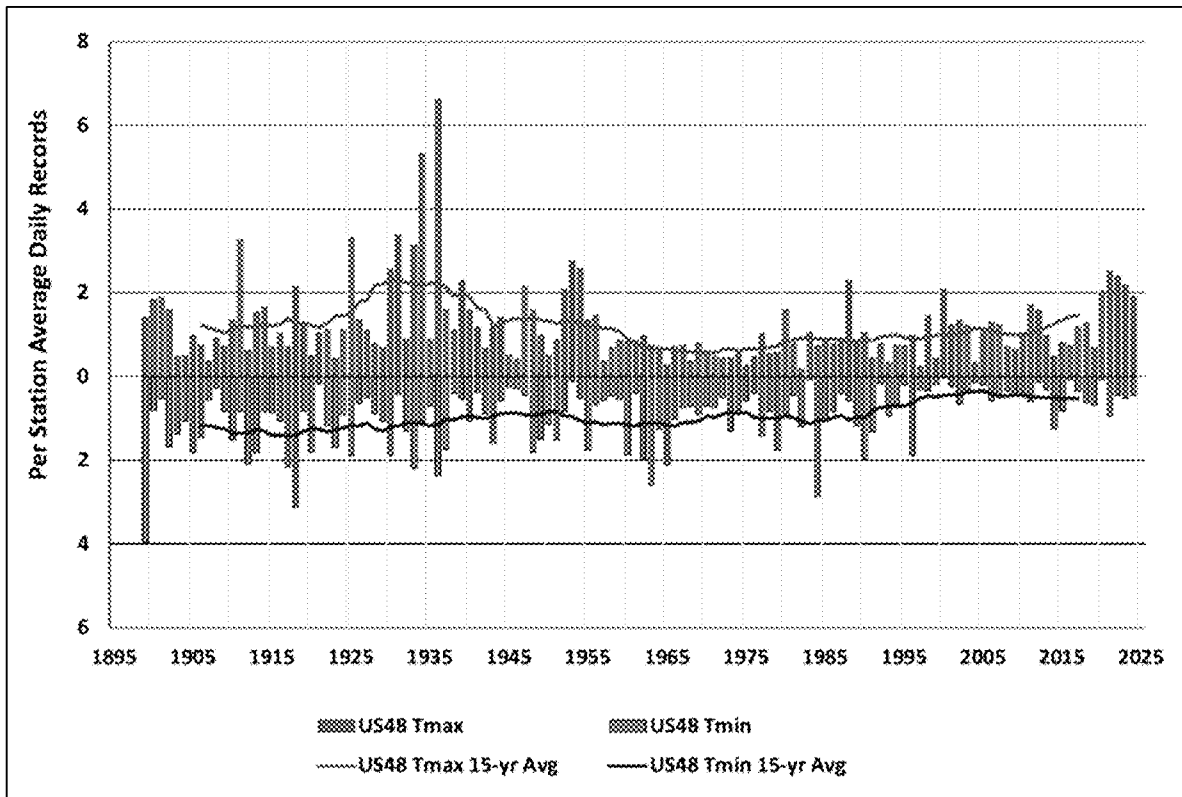


Figure ES.5: Observed changes in the occurrence of record-setting daily temperatures in the contiguous United States. Red bars indicate a year with more daily record highs than daily record lows, while blue bars indicate a year with more record lows than highs. The height of the bar indicates the ratio of record highs to lows (red) or of record lows to highs (blue). For example, a ratio of 2:1 for a blue bar means that there were twice as many record daily lows as daily record highs that year. (Figure source: NOAA/NCEI). From Figure 6.5 in Chapter 6.

The figure appears to validate the claim that, as its title says, record warm daily temperatures are occurring more often. But the underlying data do not: rather, they show that extreme heat in the U.S. peaked in the 1920s and 1930s and declined thereafter, as NCA4 Figure 6.4 in the report itself shows.

In fact, Figure ES.5 does not even show what its title implies. These are not simple counts of cold and warm extreme events, but rather they are ratios of the two counts. In fact, both types of extremes declined over the sample interval, but cold events declined more than warm events, so the ratio of warm extremes to cold extremes goes up. By graphing the ratio instead of counts, NCA4 created a visual impression opposite to what is in the data.

Figure 6.3.3 of CWG25 (reproduced below) shows the results of a proper analysis – defining each record as the singular extreme in the history, displaying numbers of warm and cold records separately, and beginning the analysis in 1899 rather than 1930. It makes evident the exceptional heat of the 1920s and especially the 1930s, peaking in 1936. The increased heat of the past five years is too brief to be deemed climatically significant and, in any event, occurred after the CSSR was published in 2017. The frequency of cold records has declined, especially over the last quarter of the period in which only 13 percent of the extreme cold events were measured. In contrast, 25 percent of the extreme heat records were achieved in the last quarter, which is consistent with statistical expectations. As a result, the ratio shown in the CSSR explodes in recent decades. The overall reduction in numbers of both cold and hot extremes over the past century indicates a climate *less* prone to extremes, in sharp contrast to the message of the NCA4 Figure.



Number of daily record High (red) and Low (blue) temperatures for warm and cold seasons in the CONUS. The lines represent the 15-year running, centered average. Source: 1,211 USHCN stations supplemented as needed to achieve a minimum of 92 percent of observations in the 126-year period since Dec 1898. US48: contiguous U.S. states. Tmax: maximum temperature. Tmin: minimum temperature. Source: CWG25 Figure 6.3.3.

The National Academies' expert review panel criticized the discussion of temperature extremes in a late draft of the CSSR. In reference to the CSSR's Key Finding 2 of Chapter 6, they said:

Further, it is difficult to understand how a statement that includes increases in extreme warmth can be associated with a high confidence or extremely likely statement, given that most of the graphics in this chapter show a decrease in extreme warmth in the historical record.

The Federal official in charge of the CSSR (Michael Kuperberg, Executive Director of the USGCRP) responded to the Academies' review by noting that

Almost every recommendation from the NAS was incorporated [in the final version]... and a new figure was added on changes in record high and low temperatures

The "new figure" referred to is the Figure ES.5, which did not appear in the draft reviewed by the Academies' panel. It seems unlikely that the Academies panel ever saw that figure because they surely would have commented if they had and it wouldn't have survived to publication. And the figure's problems were evidently not flagged (or were ignored) in the subsequent internal government reviews.

With this background we now present our critique of NCA5.

2 OVERVIEW CHAPTER: HYPERBOLIC ADVOCACY LANGUAGE AND UNSCIENTIFIC TONE

The opening Chapter 1 “Overview” is critical to NCA5 since it summarizes the whole report and is the only section that many will read. Although the later chapters of NCA5 contain much sound scholarly content, Chapter 1 is marred by a pervasive tone and language aggressively promoting emission reduction policies. The authors must have known this chapter would be mined for quotes by the media and activists looking to add an imprimatur of scientific authority to oversimplified declarations of opinion. Many examples can be cited; here we note a few that are particularly egregious.

Chapter 1 opens as follows:

The more the planet warms, the greater the impacts. Without rapid and deep reductions in global greenhouse gas emissions from human activities, the risks of accelerating sea level rise, intensifying extreme weather, and other harmful climate impacts will continue to grow. Each additional increment of warming is expected to lead to more damage and greater economic losses compared to previous increments of warming, while the risk of catastrophic or unforeseen consequences also increases.

This statement presupposes all warming is anthropogenic, all warming is bad and causes economic damage, and warming causes extreme weather to intensify. Further, there is no quantification – even if risks increase, how big are they? Such sweeping generalizations go well beyond what science has or can establish. A scientifically-sound version of this paragraph would instead say something like the following:

The Earth is warming because of a combination of natural and anthropogenic influences. This warming will generate a mix of benefits and harms that varies by region and to which society should be prepared to adapt. Some types of extreme weather have worsened recently while others have not changed or have even declined in intensity. Reducing emissions of greenhouse gases might slow the warming although such policies have proven to be costly and disruptive, so any climate actions should be weighed against the potential benefits.

On the next page the Overview goes on to say:

Each additional increment of warming leads to greater risks [here it lists 7 key components of society including food security and the economy] ... Without deeper cuts in global net emissions, climate risks to the US will continue to grow... Action to limit future warming and reduce risks can have near-term benefits and opportunities: low-carbon energy jobs, Improved air quality, Health benefits, Economic benefits...”

The authors write as if climate policy does not involve trade-offs and all measures to reduce future warming will be effective and beneficial. But the vast body of scholarship on climate science and economics does not support such simplistic claims. Not every additional increment of warming leads to economic harms, indeed (as is acknowledged in NCA5 Chapter 19 on Economics) in some cases

there will be benefits. Nor is climate policy guaranteed to create jobs or benefit the economy; in many cases it has done the opposite. Such deceit is a disservice to policymakers.

NCA5 Page 1-9 promotes renewable energy options by noting, correctly, that the levelized costs of wind/solar generation have fallen sharply since 2010. Yet it has long been known that intermittent renewables generation must be supplemented by dispatchable generation to meet grid reliability standards, and that doing so (e.g., through gas, fission, or storage) more than doubles the cost of electricity. Further, there are yet unmet synchronization challenges in wind/solar-heavy grids. Here again it is advisory malpractice not to acknowledge these facts.

Page 1-14 presents future emission scenarios with the following description: “Climate modeling experts develop global climate projections for a range of plausible futures.” The word “plausible” is applied to all the scenarios. The accompanying Figure includes both SSP3-7.0 and SSP5-8.5, the latter reaching the same radiative forcing as RCP8.5. The figure does not contrast observed emissions against previous projections, nor does it caution readers that SSP3-7.0 and SSP5-8.5 are extreme worst-case scenarios that, like RCP8.5, have been heavily criticized in the scientific literature (CWG25 3.2.1). By describing the entire envelope of emission projections as “plausible” the report opens the door to later presenting impacts associated with extreme and implausible emission scenarios as part of a baseline “business-as-usual” future.

[We could criticize Figure 1.6, which uses an anecdote to support its 1200 claim.]

Page 1-17 (and elsewhere) invokes the NOAA Billion Dollar Dataset as an indicator of extreme weather getting worse. Scientists have shown that this is an invalid metric (CWG 10.2) since it measures the growth of the economy not the frequency of extreme weather, and indeed NOAA has withdrawn the data product. Even though it was still distributed by NOAA at the time of the NCA5, the report authors should have assessed it skeptically and seen that it was unfit for the purpose of measuring climate trends.

Page 1-23 states, in large font:

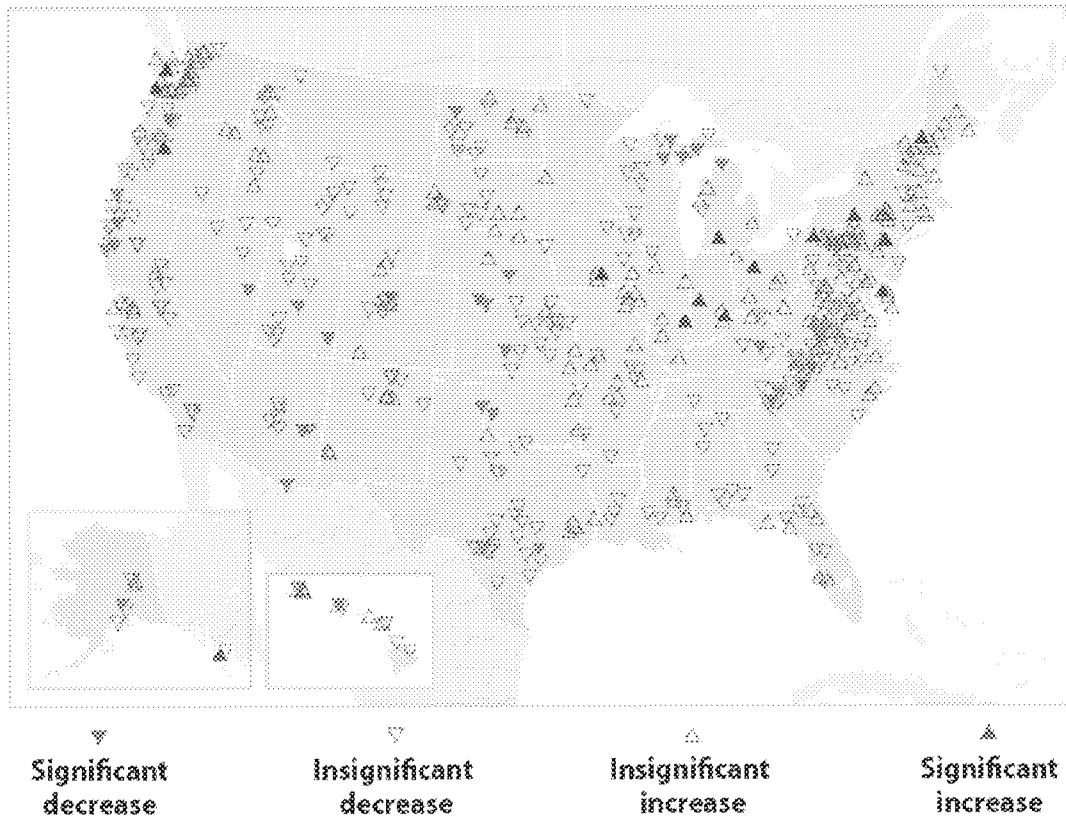
Climate changes are making it harder to maintain safe homes and healthy families; reliable public services; a sustainable economy; thriving ecosystems, cultures, and traditions; and strong communities.

It is pointless to try to evaluate this statement on scholarly grounds; it is self-evidently hyperbolic. This kind of language doesn’t belong in a scientific assessment report. Its prominent inclusion points not only to the willingness of NCA5 authors to promote hysteria, but also the ineffectiveness of the review process in removing such statements.

We won’t try to cite all the remaining examples of advocacy and hyperbole in the Overview chapter; one more example will suffice. Page 1-26 states “Increasing flooding puts more people and assets at risk.” The accompanying figure contrasts model-projected flood losses by county in 2050 to that observed in 2020 as estimated in Wing *et al.* (2022)¹. The evidence for the claim is thus not observed trends, but rather a model-generated projection of changes. Current trends in U.S.-based flooding reveal a more complex picture with a general overall trend towards *less* flooding. The Environmental

¹ Wing, Oliver, William Lehman, Paul Bates *et al.* (2022) Inequitable patterns of US flood risk in the Anthropocene. *Nature Climate Change* 12 156—162 <https://www.nature.com/articles/s41558-021-01265-6>

Protection Agency's "Climate Change Indicators: River Flooding" webpage² shows maps both of flood magnitude and frequency. Both show more regions experiencing declines over 1965-2015 than increases. Hence current trends indicate generally declining U.S. flood risks, but the NCA5 Overview not only fails to mention this but declares the opposite based on a single study presenting model-generated forecasts of flood activity decades in the future.



U.S. Flood magnitude trends 1965-2015.

Source: <https://www.epa.gov/climate-indicators/climate-change-indicators-river-flooding>

² <https://www.epa.gov/climate-indicators/climate-change-indicators-river-flooding>

3 OVERCONFIDENCE WHEN STATING CONCLUSIONS

3.1 Inflated certainty levels

Overconfidence in stating conclusions is an endemic problem in NCA5. The authors frequently make sweeping generalizations without appropriate caveats or acknowledging uncertainties. The overconfidence begins with inflated certainty levels.

The NCA5 uses specific terms to convey information about scientific confidence associated with important findings, observations, and projections. The Front Matter of the NCA5 states that “confidence in a finding is based on the type, amount, quality, strength, and consistency of evidence; the skill, range, and consistency of methods to detect, evaluate, attribute, and interpret climate trends; and the degree of agreement across scientific information sources.” Its Table 1 provides calibrated language for confidence assessment:

- **Very high:** Strong evidence (established theory, multiple sources, well documented and accepted methods, etc.). High consensus
- **High:** Moderate evidence (several sources, some consistency, methods vary and/or documentation limited, etc.). Medium consensus
- **Medium:** Suggestive evidence (a few sources, limited consistency, methods emerging, etc.) Competing schools of thought.
- **Low:** Inconclusive evidence (limited sources, extrapolations, inconsistent findings, poor documentation and/or methods not tested, etc.). Disagreement or lack of opinions among experts.

This terminology is inflated: *high confidence* with just moderate evidence and medium consensus; *medium confidence* with only suggestive evidence and competing schools of thought. This inflation in terminology leads to overconfidence in conclusions.

Even with this inflated terminology, NCA5 further inflates the confidence level of many of its conclusions to well beyond what the IPCC has concluded with more thorough justification, and also by incorrectly applying its own standards. Here are two examples:

Key Message 3.1 Traceable Account states:

“There is *very high confidence* that emissions of GHGs from human activities, fossil fuel use in particular, have unequivocally caused *all* global warming observed over the industrial era.”

While the corresponding statements from the IPCC AR5 and AR6 are:

AR5: “It is *extremely likely* that *more than half* of the observed increase in global average surface temperature from 1951 to 2010 was caused by the anthropogenic increase in greenhouse gas concentrations and other anthropogenic forcings together.” (IPCC, 2013)

AR6: “The *likely* range of total human-caused global surface temperature increase from 1850–1900 to 2010–2019 is 0.8°C to 1.3°C, with a best estimate of 1.07°C. It is *likely* that well-mixed

GHGs contributed a warming of 1.0°C to 2.0°C, other human drivers (principally aerosols) contributed a cooling of 0.0°C to 0.8°C, natural drivers changed global surface temperature by –0.1°C to +0.1°C, and internal variability changed it by –0.2°C to +0.2°C. It is *very likely* that well-mixed GHGs were the main driver of tropospheric warming since 1979.” (IPCC, 2021)

The IPCC AR5 and AR6 statements provide likelihood assessments but not a confidence level. While the NCA5 claims with *very high confidence* that fossil fuels have unequivocally caused *all* global warming, the AR5 refers to “*more than half* of the observed warming” and the AR6 provides a more nuanced statement that relates to a *likely* range of warming contributed to by human drivers.

As the second example, NCA5 Key message 2.2 reads:

“Hurricanes have been intensifying more rapidly since the 1980s (*high confidence*) and causing heavier rainfall and higher storm surges (*high confidence*).”

No justification is provided in Chapter 2 for the *high confidence* conclusion about higher storm surges or hurricanes causing heavier precipitation. The Traceable Accounts section, Description of Confidence and Likelihood states:

“Basic physical understanding and climate models both provide robust explanations for the links between climate change and observed changes in these extremes: this is why the authors also have *high confidence* that storms are delivering more rainfall and high confidence that storm surges are becoming higher.”

In short, NCA5 provides no observational basis or published research for their *high confidence* assertions that hurricanes are causing heavier rainfall and higher storm surges, thus failing meet its own standards for a *high confidence* level.

3.2 Range of climate sensitivity

Chapter 3 (Earth System Processes) states, on page 3-10, Key Message 3.2: “The Estimated Range of Climate Sensitivity Has Narrowed by 50%”. Referring to Equilibrium Climate Sensitivity (ECS) the section elaborates:

Recent improvements in the understanding of how climate feedbacks vary across timescales have narrowed the estimated *likely* range of warming expected from a doubling of atmospheric carbon dioxide by 50% to between 4.5°F and 7.2°F (*high confidence*).... This uncertainty reduction results from advances in combining observations and targeted modeling results from nearly independent lines of evidence, each of which generally agrees on the values of ECS. The lines of evidence include 1) observed present-day variations on monthly to interannual timescales from which cloud and other climate feedbacks are inferred; 2) observed temperature changes between the preindustrial period and present and associated relationships to ERF; and 3) estimated temperature and radiative forcing changes for multiple warm and cold periods in paleoclimate records.

The graphic summary on page 3-11 states

The reduced uncertainty in climate sensitivity and climate feedback has been achieved through unprecedented quantitative synthesis of evidence from observed changes over recent decades, the industrial era, and paleoclimate.

This is a grossly inadequate description of the situation. The key development in AR6 was a *reduction* of confidence in the ability of climate models to identify ECS and the shift away from the model-based method the IPCC had relied on since AR1 in 1990. The IPCC instead turned to data-driven ECS estimation and specifically chose a single paper from the scientific literature, Sherwood *et al.* (2020³) for the purpose. It combined paleoclimate data, modern instrumental data and modern observations of climate processes, mainly cloud-related, that govern key feedbacks. Sherwood *et al.* used a subjective Bayesian method to determine the likely range of ECS values. The Bayesian approach begins with the researcher specifying a “prior”, an expectation of the likely distribution of answers before seeing the data. In this case the prior is an expected ECS range based on the researchers’ subjective beliefs. The data are then allowed to influence the ECS distribution, and the final result is a weighted average of the assumed prior and the data-driven result. Sherwood *et al.* found a best (or median) ECS estimate of 5.4°F (3°C), which was close to previous model-based estimates but raised the likely lower bound by 1.7°F from 2.5°F to 4.2°F. The IPCC accepted this result and increased the best estimate to 3.1°C.

The NCA5 was published in November 2023. Well before that, in September 2022, Lewis (2023) had been published online at *Climate Dynamics* presenting a forceful critique of Sherwood *et al.*⁴ One of Lewis’ points was that Sherwood *et al.*’s result was dependent on their chosen subjective prior. Lewis recommended using an objective Bayesian method, which places primary weight on the data rather than the researcher’s expectation. Using that method and updated forcing data from AR6, Lewis estimated an ECS best estimate of 4.0°F (2.2°C) with a likely lower bound of 2.9°F (1.6°C).

Hence, in contrast to the promotional language of Chapter 3 a more valid summary of the ECS literature as it stood at the time of writing the NCA5 would be what we wrote in CWG25 (emphasis added):

For the AR6, the IPCC placed primary weight on the results of Sherwood *et al.* (2020) that combined historical and paleoclimate proxies with the process-based approach and yielded a best estimate of 3.1°C with a *likely* range of 2.6-3.9°C. Lewis (2022) raised a number of concerns about this result, including methodological errors, outdated input values, and use of subjective versus objective Bayesian priors in the analysis. Lewis’ analysis found that climate sensitivity is estimated to be much lower and better constrained than in the Sherwood *et al.* analysis – median 2.2°C (1.8–2.7°C in the 17–83 percent *likely* range, and 1.6–3.2°C in the 5–95 percent *very likely* range). **The IPCC AR6 estimated only a 5 percent probability that ECS was below 2.3°C, whereas Lewis estimated it to be over 50 percent.** The most recent publications on the debate between Sherwood *et al.* and Lewis further defend their respective positions: Sherwood and Foster (2024) and Lewis (2025).

3.3 New emission scenarios as a scientific “advance”

³ Sherwood, S. C., Bony, S., Boucher, O., Bretherton, C. S., Forster, P. M., Gregory, J. M., & Stevens, B. (2020). An assessment of Earth’s climate sensitivity using multiple lines of evidence. *Reviews of Geophysics*, 58(4). <https://doi.org/10.1029/2019rg000678>

⁴ Lewis, N. (2023). Objectively combining climate sensitivity evidence. *Climate Dynamics*, 61(9–10), 3155–3163. <https://doi.org/10.1007/s00382-022-06398-8>. The final citation for this paper is Lewis (2023) because the print edition did not appear until 2023, but the article was accepted in August 2022 and the online edition appeared and was in circulation in September 2022.

Chapter 3 pages 13-14 treats the release of new emission scenarios as a scientific “advance” without addressing the failure of many previous scenarios to match reality or providing an honest assessment of the likelihood that the new ones remain biased in the same way.

Key Message 3.3 states “New Data and Analysis Methods Have Advanced Climate Science” and includes the following:

New scenarios of socioeconomic development, and their associated emissions and land-use changes, drive updated climate projections from Earth system models. The Scenario Model Intercomparison Project (ScenarioMIP) organized the main set of 21st-century projection experiments under the latest phase of the Coupled Model Intercomparison Project, CMIP6. These CMIP6 projections used newly developed scenarios based on Shared Socioeconomic Pathways (SSPs; Figure 3.4). Five SSPs represent alternative plausible trajectories of 21st-century GDP and population growth and the pace and pervasiveness of socioeconomic and technological progress within individual nations and across the world (see Table 3 in the Guide to the Report). SSP-specific drivers are used in integrated assessment models (IAMs) to simulate the corresponding evolution of the energy system and the resulting greenhouse gas trajectories. These are in turn used by ESMs to drive their 21st-century projections.

There is nothing wrong with NCA5 discussing the development of new emission scenarios which serve as inputs to climate change projections and impact studies. But it is a serious omission not to inform the reader of the failure of many previous IPCC scenarios to match reality and the tendency of the scenario groups to exaggerate near-term and long-term growth of CO₂ concentration (CWG25 3.2.1). It is also a serious omission not to caution readers that many climate impact studies use RCP8.5 which had already been heavily criticized in the literature by the time of NCA5.

The same section also reports the availability of new and larger model ensembles as a scientific advance, without addressing ways in which models are getting worse in some key respects (CWG Ch 5).

3.4 “Emergent Constraints” and uncertainty in climate projections

Chapter 3 page 17 presents the topic of “emergent constraints” in uncritical terms:

An approach to reduce uncertainty in climate change projections has matured over the past decade. It is known as “emergent constraints.” The term refers to strong statistical relationships between highly uncertain future climate parameters and observable trends or variations in the current climate, along with a physical explanation of this relationship.

Emergent constraints appeared in the climate modeling literature as an attempt to tie GCM behavior to climate observations in hopes of generating insight into real-world ECS. Climate models exhibit a wide range of sensitivities. The idea of emergent constraints is to examine whether the models with shared sensitivity values also share a common representation of some climate process (usually related to clouds) that might indirectly influence ECS. Suppose, for instance, that in low-ECS models the total cloud fraction in the tropics is strongly correlated with that in the southern midlatitudes but in high-ECS models the correlation is weak. Then researchers could check if the observed correlation is strong or weak and draw a conclusion about which type of model, and therefore which ECS value, is more likely.

A problem in the emergent constraint literature is that there has been a large proliferation of proposed correlations with little physical motivation. Many emergent constraints patterned on CMIP5 models failed to work on CMIP6 models (Schlund *et al.* 2020)⁵. In other words, the observed correlations in CMIP5 models between ECS and cloud processes failed to show up in CMIP6 models, indicating that they were likely spurious rather than clues to physical processes governing the Earth climate system. The result was that emergent constraints estimated on CMIP5 models widened the range of estimated ECS values when applied to CMIP6 models.

Schlund *et al.* summarized the problem as follows:

In this study, we systematically analyze 11 published emergent constraints on ECS that have mostly been derived from models participating in the Coupled Model Intercomparison Project Phase 5 (CMIP5) project... The focus of the study is on testing if these emergent constraints hold for [Earth System Models] participating in the new Phase 6 (CMIP6). Since none of the emergent constraints considered here have been derived using the CMIP6 ensemble, CMIP6 can be used for cross-checking of the emergent constraints on a new model ensemble. **The application of the emergent constraints to CMIP6 data shows a decrease in skill and statistical significance of the emergent relationship for nearly all constraints, with this decrease being large in many cases.** Consequently, the size of the constrained ECS ranges (66% confidence intervals) widens by 51% on average in CMIP6 compared to CMIP5.

Yet NCA5 described the use of emergent constraint analysis as a great “advance” that reduced uncertainty.

3.5 Overstating findings in underlying sources

Although we did not do a detailed audit of the NCA5’s use of source material, a few spot checks turned up evidence of a pattern of overstatement.

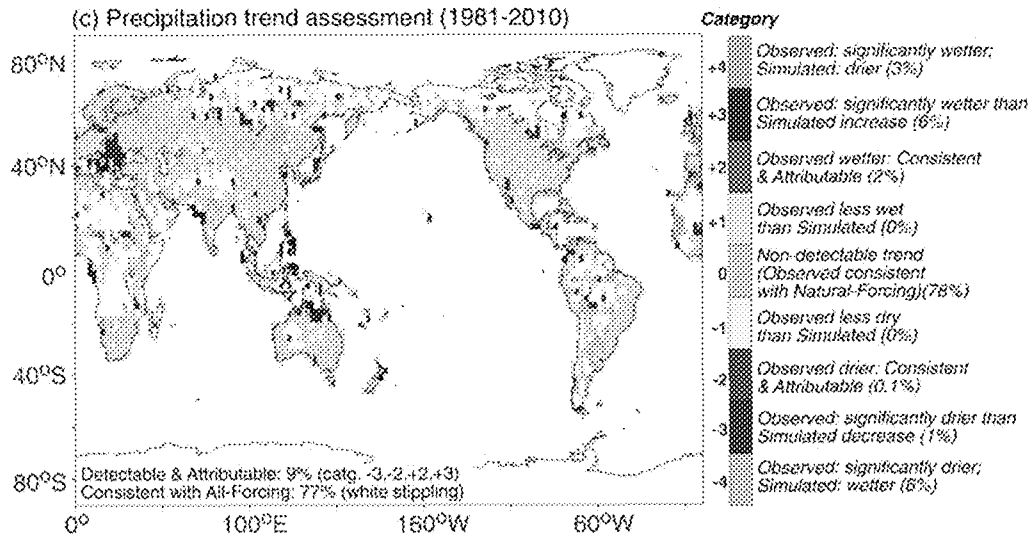
Chapter 2 page 2-11 reports on an increase in precipitation in central and eastern US based on a comparison of 2002-2021 average rainfall to the average over 1901-1960. Note that this a non-standard metric; we will discuss NCA5’s inconsistent choices of time scales of analysis below. The change in this case is called a “trend” even though this is not how a trend is measured, and says that it is “attributable to climate change”.⁶ The claims were attributed to the following paper:

- Knutson, Thomas and Fanrong Zeng (2018) “Model Assessment of Observed Precipitation Trends over Land Regions: Detectable Human Influences and Possible Low Bias in Model Trends” *Journal of Climate* 31(12)
<https://journals.ametsoc.org/view/journals/clim/31/12/jcli-d-17-0672.1.xml>

⁵ Schlund, Manuel, Axel Lauer, Pierre Gentine, Steven C. Sherwood, and Veronika Eyring (2020) Emergent constraints on equilibrium climate sensitivity in CMIP5: do they hold for CMIP6? *Earth System Dynamics* 11 1233-1258 <https://doi.org/10.5194/esd-11-1233-2020>

⁶ This statement of attribution is misleadingly ambiguous. Because NCA5’s Glossary defines “climate change” as a change in climate for any reason, the statement is a tautology and hence superfluous. But because the popular perception of climate change is anthropogenic, its gratuitous inclusion effectively attributes the changes to greenhouse gas emissions.

But Knutson and Zeng did not say these things. It examined linear trends over 1901 – 2010, 1951 – 2010 and 1981 – 2010. It did not compare average rainfall over 2002 - 2021 to average rainfall over 1901 – 1960, indeed it was published in 2018 so it could not have. Its results for 1981-2010 trends were summarized in the following figure:



Gray indicates no trends detected. Stippling means that there were no trends in the models either so the models and observations agreed in that respect. Detectable and attributable trends were found over only 9% of the land surface of the Earth. Over the US there are detectable trends over only a few regions in the Southwest.

As another example of overstating findings, NCA5's Chapter 2 page 2-18 states

There is robust evidence that human-caused warming has contributed to increases in the frequency and severity of the heaviest precipitation events across nearly 70% of the US.

This is allegedly supported by two papers:

- Diffenbaugh, N.S., D. Singh, and J.S. Mankin, 2018: Unprecedented climate events: Historical changes, aspirational targets, and national commitments. *Science Advances*, **4** (2), 3354. <https://doi.org/10.1126/sciadv.aao3354>

and

- Kirchmeier-Young, M.C. and X. Zhang, 2020: Human influence has intensified extreme precipitation in North America. *Proceedings of the National Academy of Sciences of the United States of America*, **117** (24), 13308-13313. <https://doi.org/10.1073/pnas.1921628117>

Diffenbaugh et al. presented ratios of observed occurrences of extreme events to simulated occurrence rates in CMIP6 models run with only natural forcings. They report that for 79% of the U.S. extreme rainfall event frequencies are currently higher than in model simulations, and the ratio of

occurrences will rise under future warming simulations. This is not “robust” evidence of anthropogenic influence since it rests on the assumption that climate models provide accurate simulations of regional precipitation patterns, something that even the IPCC AR6 admits is uncertain (AR6 WGI SPM Box SPM 1.2, SPM Section C.1.3).

Kirchmeier-Young and Zhang looked at extreme 1- and 5-day events in North America and, using 3 GCMs, found

“A signal of combined anthropogenic and natural external forcing can be detected in the intensification of extreme precipitation at the continental scale over North America. In some cases, this intensification can be attributed to human influence specifically.”

However, they noted large differences among the three models in their simulated precipitation changes. Also, two of the three models failed to yield detection for Rx5Day for the North America mean. Finally, the authors used Total Least Squares, an estimation method known to overstate signal detection results (CWG Section 8.3.2). Here again, this is not “robust” evidence. Rather, it is suggestive, but other studies have found natural variability predominant. Both cited references utilized the implausible RCP8.5 scenario and began their “historical” observational records only in 1961.

4 RELIANCE ON *Ad Hoc* TIME SCALES FOR TREND ANALYSIS

In CWG25 Chapter 6 we discussed the need for care in the choice of time scale when making claims about trends in extreme weather. We gave examples from analysis of river flooding (Section 6.1), heatwaves (Section 6.3) and extreme precipitation (Section 6.4) to show how assertions about apparent trends based on short data sets fall apart when looking at longer versions of the same data sets. Here we elaborate on these examples to illustrate a general point that NCA5 made inconsistent and *ad hoc* choices about time scales of analysis, weakening the validity of their conclusions.

4.1 Average and Extreme Precipitation

McKittrick and Christy (2019)⁷ showed that apparently significant positive trends in U.S. average and extreme precipitation over the NCA4 interval (1901 – 2016) disappeared on longer samples (extending back as far as the 1840s depending on location or on a shorter interval coinciding with the final 40 years of the data then available (1978 – 2017).

In CWG Section 6.4 we presented analysis of updated data for the same locations and many more besides, in all cases finding considerable regional heterogeneity and lack of robustness of trends to use of long samples.

NCA5 did not continue the NCA4 precedent of using the post-1901 interval as the time scale for its precipitation discussion, instead it refers to changes “since the 1950s”, which we take to mean 1950 onwards (although NCA5 Fig. 2.8 suggests 1958 as the start date). For the present report we have extended the analysis even further now to include 141 stations across the US in the Pacific Coast, Midwest, Northeast and Southeast regions. We provide details in Appendix XX; here we note merely that once again it is possible to find trends that support the NCA5 position, but they are not robust to selecting longer or shorter time scales of analysis. Data from 1950 to 2024 yields many indications of increased average and extreme precipitation at individual stations and region-wide averages. But when using the entire data set (back to the 1890s or earlier depending on location) or the later subset (1980 to 2024) the trends become smaller, in many cases they become statistically insignificant, and occasionally they change sign. Only in the Northeast region are the post-1950 trends robust to focusing on the post-1980 interval.

Under Key Message 2.2 “Extreme Events Are Becoming More Frequent and Severe” (p. 2-16) NCA5 states (p. 2-18):

“Rainfall is becoming more extreme”

Since the 1950s, there has been an upward trend in heavy precipitation across the contiguous US. This increase is driven largely by more frequent precipitation extremes, with relatively smaller changes in their intensity. The largest increase in the number of extreme precipitation days (defined as the top 1% of heaviest precipitation events) has occurred over the Northeast (an increase of around 60%) and Midwest (around 45%), along with increases of more than 10% in their annual and 5-year maximum amount (Figure 2.8). These changes have contributed to increases in river and stream flooding in

⁷ McKittrick, R., and J.R. Christy (2019). Assessing changes in US regional precipitation on multiple time scales. *Journal of Hydrology*, 578, 124074. <https://doi.org/10.1016/j.jhydrol.2019.124074>

these regions. The increase in frequency and intensity of precipitation extremes is evident across a broad range of event durations (from 1 to 30 days) and return intervals (1 to 20 years), particularly east of the Rocky Mountains.

There is robust evidence that human-caused warming has contributed to increases in the frequency and severity of the heaviest precipitation events across nearly 70% of the US. Paleoclimate records derived from tree-ring growth provide evidence that summer moisture has increased over the past century in parts of New England, the central-eastern US, and the northern Mississippi River valley.

The following is a more accurate summary of what U.S. data show.

There are regionally heterogeneous changes in average and extreme precipitation. Positive trends in annual average rainfall and extreme events (defined either as the annual maximum or the number of exceedances of the 99th percentile value) are generally weak or non-existent when looking at samples exceeding 130 years in length. Significant trends can be found when beginning the sample in the 1950s although in most cases the trends weaken and become insignificant when looking at the post-1980 interval. This makes attribution to anthropogenic warming difficult.

Along the Pacific coast very few stations (1 or 2 out of 29) exhibit significant trends on any time scale in any metric and the region-wide trends are insignificant. In the Southeast region about 5 out of 24 stations exhibit positive trends in average and extreme precipitation metrics and the regional trends are likewise significant, but only on samples beginning in 1950. When the sample starts in 1873 or 1980 the trends weaken and become mostly insignificant. In the Midwest region nearly half the stations exhibit positive and significant trends in average precipitation since 1893 (23 of 61) and 1950 (28 of 61) but the trends weaken after 1980: only 6 of 61 locations are significant and the region-wide trend is insignificant. These positive trends reflect the dryness of the 1930's Dust Bowl era. Regional trends in max and 99th percentile exceedances are insignificant post-1893 and -1980 but the latter are positive and significant post-1950.

In the Northeast region 12 out of 27 stations exhibit positive and significant increases in average precipitation post-1888, post-1950 and post-1980 (10 of 27) and the regional trend is positive and significant in all three intervals. The regional number of 99th percentile exceedances has a positive trend post-1950 and post-1980 but not post-1888. The significant positive trends post-1980 are concentrated in NH but are insignificant elsewhere.

Consequently, precipitation in the U.S. exhibits considerable regional and temporal variability. Relatively more places became wetter than drier. The general pattern in the Midwest and Northeast since 1950 favors increased precipitation depending on the location, although trends since 1980 tend not to be statistically significant.

4.2 Heatwaves

There are mixed (and somewhat convoluted) messages in NCA5 regarding the notion that hot extremes are increasing in CONUS. NCA5 Chapter 2 offers these statements about extremes in heat on pg. 2-16:

[Key Message 2.2] Extreme Events Are Becoming More Frequent and Severe

Observations show an increase in the severity, extent, and/or frequency of multiple types of extreme events. Heatwaves have become more common and severe in the West since the 1980s (*high confidence*).

And later on pg. 2-17

The Risk of Temperature Extremes Is Changing

By some measures, the most extreme heatwaves on record in the United States occurred during the Dust Bowl era of the 1930s. ... Several major heatwaves have affected the US since 2018, including a record-shattering event in the Pacific Northwest in 2021. The western US has been particularly affected by extreme heat since the 1980s (Figure 2.7), experiencing a larger increase in days over 95°F, as would be expected given the greater warming in that region relative to the eastern US. By contrast, the number of very hot days has actually decreased across the central and eastern regions due to summer cooling trends in the region (Figure 2.7; Ch. 22). This does not, however, mean the central and eastern US are not affected by heat. The impacts of extreme high temperatures are more severe if such conditions persist for several days, and overall, multiday heatwaves have become hotter, more frequent, larger, and longer lasting in recent decades. Across 50 large US cities, the US Global Change Research Program heatwave indicator (<https://www.globalchange.gov/indicators/heat-waves>) shows that the average number of heatwaves has doubled since the 1980s, and the length of the heatwave season has increased from about 40 days to about 70 days.

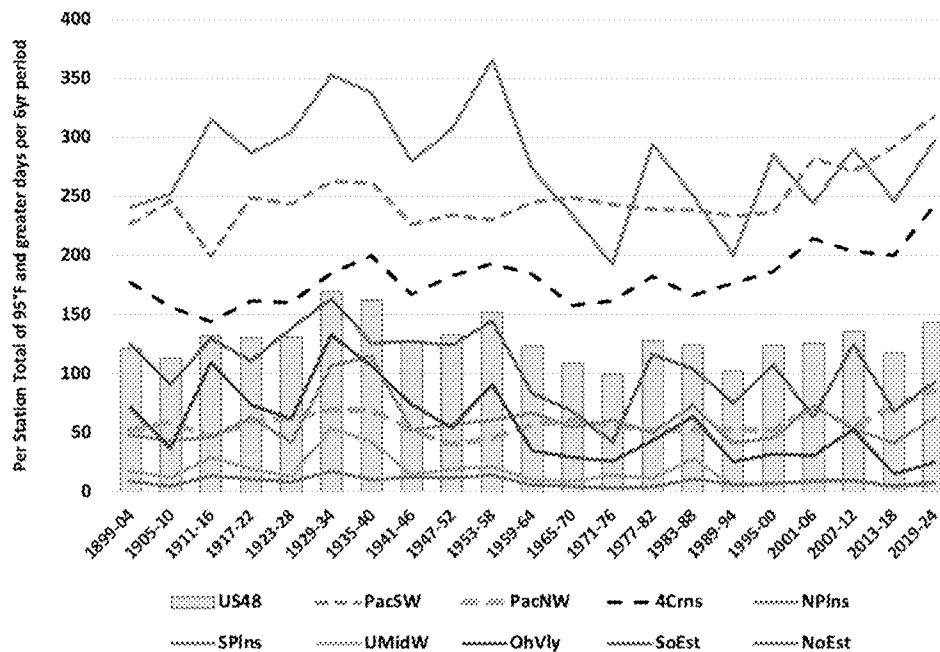
Nighttime temperatures are rising faster than daytime temperatures, and the number of nights where the temperature never falls below 70°F is increasing everywhere in the US except the Northern Great Plains (Figure 2.7). The extent of CONUS experiencing hot summer nights is growing at a faster rate than the extent experiencing hot summer days.

While these statements might be factually correct, they are misleading because they are factually incomplete. Much of NCA5's heat discussion focused on the West since the 1980's and on rising nighttime temperatures since the 1960's; the long-term decline in heat extremes in most of CONUS is barely mentioned. We also note the convoluted reasoning in the quote above that hot extremes are apparently due to "greater warming" in the western region than experienced elsewhere and that declining hot extremes elsewhere are "due to summer cooling trends". Of course, the real question is "What caused the warming *and* cooling trends?"

These heat issues were addressed in Chapter 6 of CWG25, demonstrating that the range and magnitude of extreme temperatures (10's of degrees) are driven more by the chaotic behavior of natural variability than the small forcing by enhanced concentrations of CO₂. The CWG25 conclusion is that for both (a) hot days ($\geq 95^\circ\text{F}$) and (b) number of days in heatwaves, the current decade is experiencing no more than was experienced 100 years ago. For example, in the 30-year period 1925-1954, representing only 23% of the 1899-2024 data record, CONUS experienced 33% of the total heat wave days. The most recent 30-years experienced 24%, almost exactly that expected by chance.

Thus, the claim “multiday heatwaves have become hotter, more frequent, larger, and longer lasting in recent decades,” is simply false when expanding the temporal (to 1899) and spatial (entire CONUS) domains to evaluate the data that is available (Chapter 6 Fig. 6.3.6 of CWG25).

The figure below displays the occurrence of days $\geq 95^{\circ}\text{F}$, showing the increase in the three western regions and declines elsewhere. The trends in both heatwave days and hot days are (insignificantly) negative for CONUS as a whole.



Number of days $\geq 95^{\circ}\text{F}$ in 6-year periods (1899-2024) for nine CONUS regions (lines, dashed positive trends, solid negative trends) and full CONUS (bars).

It is clear that summer nighttime temperatures have risen rapidly since 1960 nearly everywhere, and especially in the largest cities. However, and not explicitly pointed out in NCA5, this observation is more a consequence of the urban heat island effect (which has greatest impact on nighttime temperatures and on stations changing from rural to semi-rural, as discussed in Chapter 6 of CWG25) and the choice of starting in the 1960’s, the coolest decade since the 1910’s.

In attributing claims of rising heat extremes to GHG concentrations, the NCA5 concentrated on the West but is silent on the attribution of declining heat extremes in the eastern two-thirds of CONUS (the statement “due to summer cooling trends” does not suffice) or the major role that the increasing growth of infrastructure around the stations exerts on nighttime temperatures. The scientific method requires that one deals with all the available evidence, not simply a small portion that agrees with a claim. In this instance the NCA5 falls short of rigorously demonstrating that rising GHG concentrations are responsible for the observed changes (or lack thereof) in hot extremes in CONUS; those are more fully explainable by natural variability (1930’s Dust Bowl, cool 1960’s) and urbanization (nighttime warming.)

The NASEM Review provided few comments on the explicit issues of assessing the changes in extreme temperatures. Much of its review focused on social and policy issues (e.g., Comments on

Equity and Justice), rather than on the confidence we have in the scientific assumptions that prompt the social and policy discussion. We assess that the NASEM review lacked the usual rigor of challenging questionable claims and analyses. Our analysis of selected comments from the NASEM review follows.

Page 42 of the NASEM review states:

The chapter [2] meets the requirements of Section 106 of the GCRA.

This NASEM statement is of concern as the NCA5 chapter did not thoroughly address natural variability nor did it assess the full climate record available for analysis, which would better quantify natural variability. Chapter 2 actually downplays natural variability by claiming unsubstantiated skill in attributing recent extremes to human causes. For example, the Introduction of NCA5's Chapter 2 states,

"...recent advances in attribution science (KM 3.3) mean that the role of climate change in some extreme events can now be quantified in real time. For example, climate change made the record-breaking Pacific Northwest heatwave of June 2021 2° to 4°F hotter, and in 2017 ..."

Yet CWG25 demonstrates that this particular event would have happened in any case and that for CONUS, hot extremes are no more frequent now than they were in the past.

As another example, page 42 of the NASEM review offers

...the discussion and references regarding the role of natural climate variability and its regional differences are missing.

This comment is correct, but difficult to find explicit comments on in the NCA5 given that NCA5 neglected to examine over half of the available CONUS climate record which begins in the late 19th century – a period obviously dominated by natural variability. While NCA5 occasionally nods to natural variability, that is usually followed by a "however" to emphasize human influence. One example is the statement just before the claim mentioned above, NCA5:

"There has always been extreme weather, which occurs even in an unchanged climate due to the natural variability of the Earth system. However, recent advances in attribution science (KM 3.3) mean that the role of climate change in some extreme events can now be quantified in real time. For example, climate change made the record-breaking Pacific Northwest heatwave of June 2021 2° to 4°F hotter, and in 2017 ..."

And yet another example from page 43 of the NASEM review:

"Extreme Events Are Becoming More Frequent and Severe."

Key Message 2.2 is another generally well written key message. However, while the title of this key message includes the word "risk," the key message is exclusively about hazard. The Committee suggests rewriting the key message title to more accurately reflect the discussion on hazards.

The review appears to accept the NCA5's use of data records going back only to the 1960's and 1980's since it makes no critical remarks about the NCA5's neglect of the available evidence to assess longer time scales and the broader geographic area (CONUS). Rather, the NASEM review of Key Message 2.2 is only concerned about the title rather than its misleading content.

And as a final example, page 44 of the NASEM review offers:

It is also important to point out that the influence of natural climate variability becomes particularly strong when the climate trend is computed based on short periods of time or small geographic areas.

Yet this comment was largely ignored in the NCA5 final text.

5 INADEQUATE TRACEABLE ACCOUNTS

Beginning with the NCA3, every NCA has included a “Traceable Accounts” section at the end of each chapter. A description from the NCA5:

“Each chapter concludes with a section entitled Traceable Accounts, which provides information on the overall process used to develop the chapter as well as a separate Traceable Account section for each Key Message. These Traceable Accounts describe the supporting evidence behind each Key Message, the process and rationale authors used in reaching their conclusions, and the author team’s expert assessment of the confidence in and, where applicable, likelihood of these conclusions. As such, Traceable Accounts provide information about the state of the science, document sources of uncertainty, identify research gaps, and allow traceability to data and resources.”

The Traceable Accounts for each Chapter and Key Message includes the following sections:

- Description of Evidence Base
- Major Uncertainties and Research Gaps
- Description of Confidence and Likelihood

These sections could in principle address the NCA’s statutory requirement to discuss scientific uncertainties. Further, they could help satisfy the Executive Order for Restoring Gold Standard Science by addressing reproducibility, transparency, communication of error and uncertainty, and skepticism of findings and assumptions. However, the Traceable Accounts in NCA5’s Chapters 2 and 3 are uneven, often superficial and non-informative.

Here is an example from Chapter 2:

Key Message 2.2: Extreme Events are Becoming More Frequent and Severe.

Observations show an increase in the severity, extent, and/or frequency of multiple types of extreme events. Heatwaves have become more common and severe in the West since the 1980s (*high confidence*). Drought risk has been increasing in the Southwest over the past century (*very high confidence*), while at the same time rainfall has become more extreme in recent decades, especially east of the Rockies (*very high confidence*). Hurricanes have been intensifying more rapidly since the 1980s (*high confidence*) and causing heavier rainfall and higher storm surges (*high confidence*). More frequent and larger wildfires have been burning in the West in the past few decades due to a combination of climate factors, societal changes, and policies (*very high confidence*).

The “Description of the Evidence Base” offers two paragraphs, the first summarizing the findings and the second paragraph a generic description of the types of data that can be used for storms. “Major Uncertainties and Research Gaps” focuses on the uneven distribution across US populations due to differences in exposure and vulnerability. The only limitations in data referred to are the lack of a long-term record of lightning and the lack of homogenized daily and hourly temperature data, except from

reanalysis products. But the most astonishing deficiency is in the “Description of Confidence and Likelihood”, which reads

“Basic physical understanding and climate models both provide robust explanations for the links between climate change and observed changes in these extremes: this is why the authors also have high confidence that storms are delivering more rainfall and high confidence that storm surges are becoming higher.”

There is no reference to journal publications or a specific data set supporting this high confidence conclusion.

In Chapter 3, there are substantial inconsistencies between the Traceable Accounts for the different Key Findings. Key Message 3-1 reads “Human activities have caused global warming” and for Confidence and Likelihood offers:

“There is *very high confidence* that emissions of GHGs from human activities, fossil fuel use in particular, have *unequivocally* caused all global warming observed over the industrial era. There is also *very high confidence* that changes in natural climate drivers have had globally small and regionally variable long-term effects over this period.”

Yet its Uncertainties section addresses only uncertainties in radiative forcing of greenhouse gases.

By contrast, Key Message 3-4 is that “Humans are changing Earth System processes.” Its Traceability Analysis is arguably the most scientifically credible text in the entire Chapter, as the Description of Evidence Base reads:

“In the last decade, there has been increasing recognition of the role of regional-scale natural variability in the past and future evolution of climate, as well as the fact that regional natural variability signals can be competitive with forced anthropogenic signals”.

and its Major Uncertainties and Research Gaps section reads:

“For example, the true natural variability of the climate system on decadal to centennial timescales could be larger than what we estimate from GCMs, which would further increase the irreducible uncertainty stemming from natural variability.”

As part of the Traceable Account: “Each figure and some tables are accompanied by a metadata survey, which can be accessed in the online version of the report by clicking on the eyeball icon above the figure or table (see the table below for explanations of additional icons used throughout the report). The metadata survey describes data sources, figure or table development methods, copyright information, and other important documentation.” Upon clicking on the eyeball icon above a particular figure, a Contact US email appears, addressed to the USGCRP.

No attempt was made to send a email to elicit the Metadata information, but it is clear that this information is not readily accessible online.

In summary, the Traceable Analyses examined here, with few exceptions, fail to meet the stated objectives set forward by the NCA.

6 OVEREMPHASIS ON EXTREME SCENARIOS

To respond to the GCRA mandate to “project major trends for the subsequent 25 to 100 years,” the NCA relies on projections of future climate change based on estimates of future emissions (the so-

called SSP scenarios) and/or specified levels of radiative forcing (the RCP scenarios). For the most part, NCA5 uses scenarios developed for the IPCC Assessment Reports.

In CWG Section 3.2.1 we presented a critical assessment of past and current IPCC scenario envelopes, showing that they have tended to overshoot observed emissions. In 2021, UN Climate Negotiators (COP) stopped using scenarios above 4.5. The IPCC AR6 published in 2021 stated that "The likelihood of high-emission scenarios like RCP8.5 and SSP5-8.5 is considered low in light of recent energy sector developments."

NCA5 makes the following observations about the scenarios they use:

"NCA5 authors were advised to assess the full range of scenarios available."
(Front Matter)

"Scenarios of future emissions and land-use change are developed as plausible alternatives, but no relative likelihood is attached to them. Some recent studies, however, have argued that the highest scenario, SSP5-8.5, is no longer plausible without a reversal of current trends in the adoption of renewables and energy efficiency."
(Key Message 3.3 Traceable Analysis)

Despite acknowledging the issue the NCA5 otherwise ignored the problem. A keyword search of the NCA5 of mentions of RCP/SSP scenarios finds over 50% referred to the extreme emissions scenarios RCP8.5/SSP5-8.5. Further, ten NCA5 figures (5.2, 6.9, 7.4, 11.3, 14.6, 22.13, 22.19, 27.9, 29.13) included *only* the 8.5 scenarios.

The problem of relying on extreme scenarios is particularly acute for sea level rise projections. The sea level rise scenarios used in the NCA5 do not relate directly to the SSP emissions scenarios, but to specified amounts of sea level rise by 2100. Table 4 of NCA5's "Guide to Using this Report" shows that Low is 0.3 m (0.98 feet), Intermediate-Low is 0.5 m (1.64 feet), Intermediate is 1.0 m (3.28 feet), Intermediate-High is 1.5 m (4.92 feet), and High is 2.0 m (6.56 feet).

Considering only projections representing processes in whose quantification there is at least medium confidence, the IPCC AR6 assessed global mean sea level projections for 2100 to fall between 0.2 and 1.6 m (5th—95th percentile range). The corresponding range of sea level rise scenarios considered by the NCA5 is from 1.5 to 2.0 m. NCA5 neglects to include plausible lower scenarios, such as 0.2 m cited by the IPCC, which also corresponds to the average rate of sea level rise over the past century.

With regards to actual predictions of sea level rise, Chapter 9 of the NCA states: "Under a range of potential global warming levels, average sea level along US coastlines is *likely* to be between 12 and 20 inches above 2000 sea levels in 2050." These values of sea level rise encompass the Intermediate scenario to values slightly higher than the High scenario from Table 4 << which Table 4?

Global sea level rise projections to 2050 relative to a 2000 baseline can be evaluated with respect to the observed global sea level rise from 2000-2024, which is approximately 3.39 inches (0.28 feet). <https://www.climate.gov/news-features/understanding-climate/climate-change-global-sea-level> Hence it is inferred that NCA5 is projecting values of sea level rise between 2025 and 2050 that are 3.5 to 5.8 times the rate observed during 2000-2024.

Chapter 9 further states: “Looking toward the future, an 11 inch (28 cm) average rise along the contiguous US coastline is expected by 2050 (relative to 2020), with a *likely* range of 9-13 inches.” This analysis accounts for the observed sea level rise between 2000 and 2020.<< But they say it’s relative to 2020.

Considering only projections representing processes quantified with at least medium confidence, the IPCC AR6 assessed global mean sea level projections for 2100 to fall between 0.2 and 1.6 m for the 5th–95th percentile range, for all scenarios ranging from RCP2.6 to RCP8.5. The IPCC AR6 cites values as high as 2.4 m at the upper end of the 95th percentile range for RCP8.5, if estimates include the hypothesized Marine Ice Cliff Instability (low confidence).

NCA5’s Intermediate-High (1.5 m) and High (2.0 m) scenarios thus correspond to the implausible extreme emissions scenario RCP8.5 and poorly understood processes. Yet NCA5 neglects to include plausible lower scenarios, such as 0.2 m cited by the IPCC, which corresponds to the average rate of sea level rise over the past century.

Chapter 9 of the NCA states:

“Under a range of potential global warming levels, average sea level along US coastlines is *likely* to be between 12 and 20 inches above 2000 sea levels in 2050 (Figure 9.2).”

These values span from the Intermediate scenario to values slightly greater than the High scenario. They can be put into context by considering the observed global sea level rise from 2000-2024, approximately 3.39 inches (0.28 feet). NCA5 is thus projecting a sea level rise during 2025 and 2050 that is 3.5 to 5.8 times the rate observed during 2000-2024.

Chapter 9 further states: “Looking toward the future, an 11 inch 28 cm average rise along the contiguous US coastline is expected by 2050 (relative to 2020), with a *likely* range of 9-13 inches.” This analysis accounts for the observed sea level rise between 2000 and 2020.

With regards to confidence levels, NCA5 Chapter 9 Traceable Accounts states:

“There is *high confidence* and it is *likely* that sea levels will rise about 11 inches (likely range of about 9–13 inches) between 2020 and 2050”

Unfortunately, neither the statement nor the context distinguishes whether this refers to global sea level rise or US average sea level rise, although it is inferred to refer to the former.

In summary, the NCA5 presents future sea level rise scenarios that are not directly relatable to either SSP/RCP emissions scenarios nor to global warming levels. The NCA5 scenarios include two scenarios that are higher than the 95th percentile for the extreme emissions scenario RCP8.5 and include hypothesized ice sheet processes for which there is low confidence. Projections to 2050 require rates of sea level rise from 2025 to 2050 that are more than three times the rate observed during 2020-2024. Further, the NCA5 ascribes *high confidence* to these sea level rise projections.

The inclusion, and even the focus, on implausible extreme emissions scenarios supports projections of alarming impacts that are very unlikely to be driven by anthropogenic warming.

7 BIASED SELECTION OF REFERENCES

-details

8 SUMMARY: EVALUATION OF THE NCA5

8.1 Pertinent aspects when evaluating in light of statutory requirements

- not our remit to make a ruling but here are aspects to consider in light of statutory requirements

8.2 Evaluation from the perspective of expert users of the report

- we have deep knowledge of the topics surveyed by the NCA5 authors
- we do not have confidence that the report was balanced and comprehensive
- we can point to many specific instances in which the report did not exhibit an appropriate level of quality or integrity as a scientific document
- we have reason to believe the whole process, from author selection to handling of expert reviews, was biased towards reinforcing foregone conclusions and alarmist messaging

8.3 Evaluation from the perspective of citizens interested in good policymaking

- Public concerns about climate change are valid, as are concerns about cost of living, economic growth, employment, etc.
- We share the general concern that elected officials and those who serve them have the best information available when making important decisions around energy and climate policy
- NCA5 was a missed opportunity: it could have been a valuable input to that process but it did not turn out that way
- consequently its usage is unlikely to lead to better decisions and would more likely increase the error rate in policy formation and we recommend it not be used for policymaking purposes.

APPENDIX 1: Kratsios charge letter

APPENDIX 2: Seth's letter on statutory requirements for NCA5

APPENDIX 3: Analysis of 141 U.S. Longterm Daily Precipitation Records.

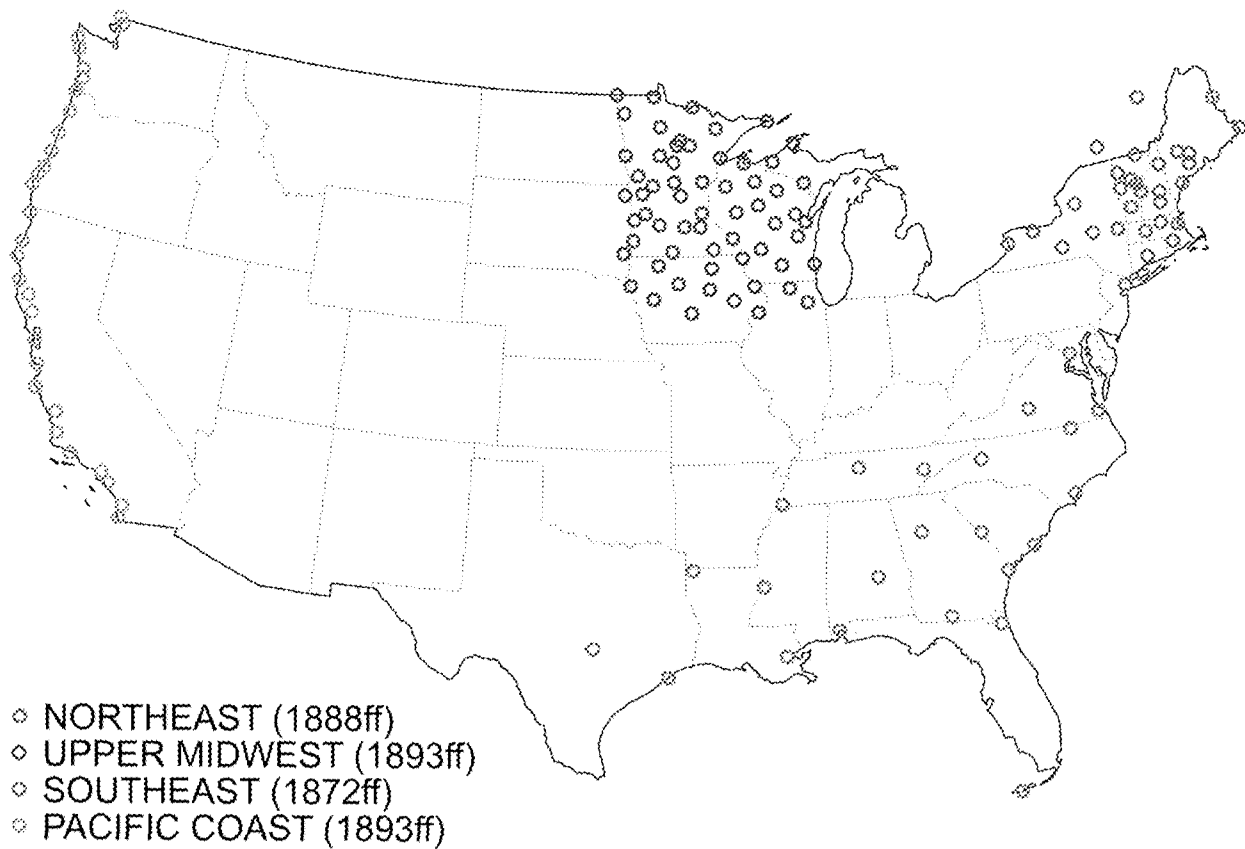


Figure. Stations used in the following analyses.

Table codes: (-) neg insignificant, -- neg significant, (+) pos insignificant, ++ pos significant.

Column 1: Measure

Column 2: Number of stations in that region

Column 3: Count of stations exhibiting a significant positive trend

Column 3: Count of stations exhibiting a significant negative trend

Column 5: Characteristic of region-wide trend

PACIFIC COAST

Since 1893:

	No. stns	+ trends	- trends	region
1-day average	29	0	1	(-)
2-day average	29	0	1	(-)
Avg on non-zero days	29	0	9	--
Variability	29	1	0	(+)
Annual max	29	2	1	(+)

Number of 99 th pct exceedances	29	1	0	(-)
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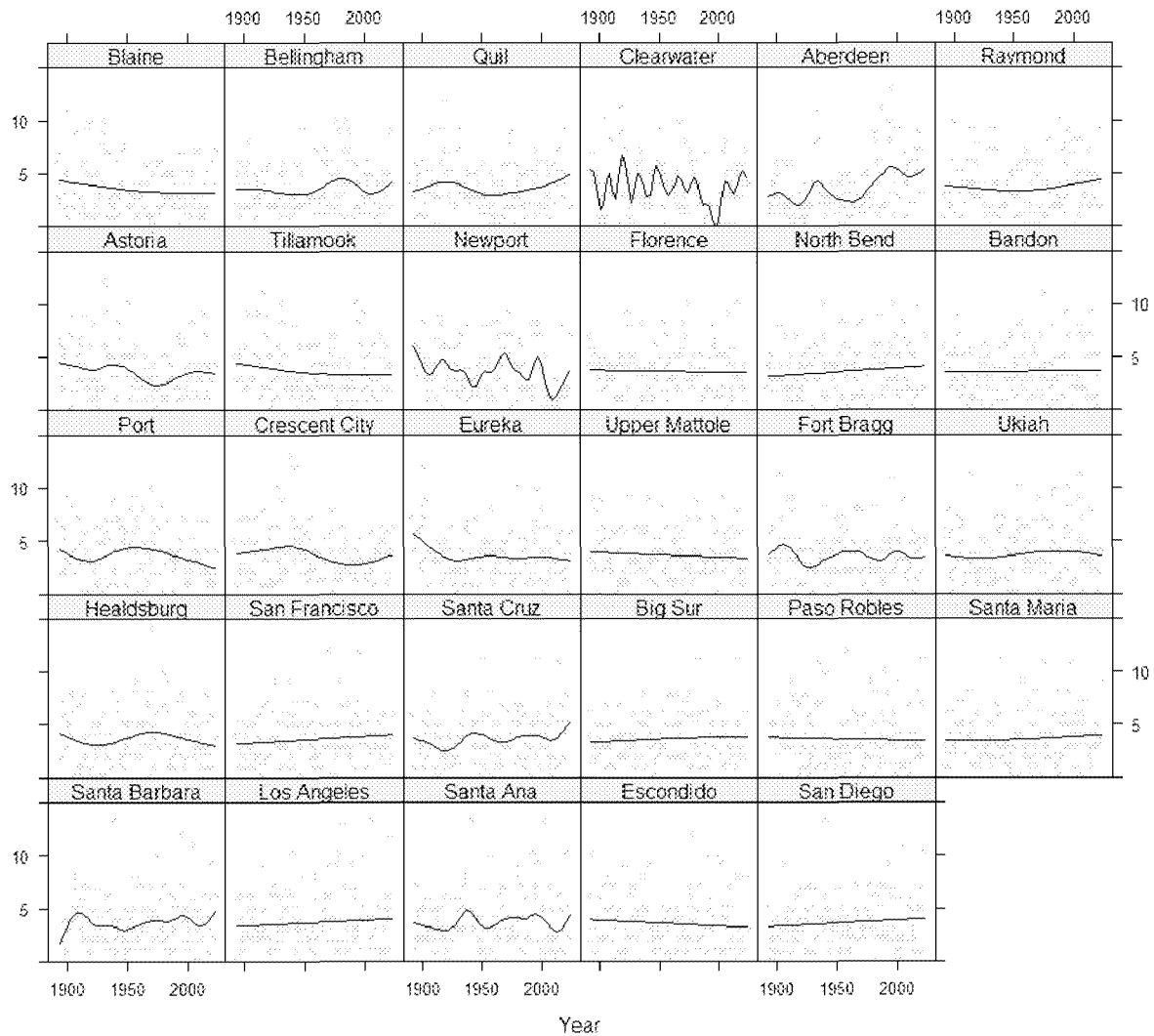
Since 1950:

	No. stns	+ trends	- trends	region
1-day average	29	0	1	(-)
2-day average	29	0	1	(-)
Avg on non-zero days	29	0	4	(-)
Variability	29	2	3	(-)
Annual max	29	6	3	(-)
Number of 99 th pct exceedances	29	2	1	(-)

Since 1980:

	No. stns	+ trends	- trends	region
1-day average	29	0	0	(-)
2-day average	29	0	0	(-)
Avg on non-zero days	29	0	1	(-)
Variability	29	0	0	(-)
Annual max	29	2	1	(-)
Number of 99 th pct exceedances	29	0	0	(+)

Annual No. 99th Percentile Exceedances PC 1893-2024



SOUTHEAST

Since 1873:

	No. stns	+ trends	- trends	region
1-day average	24	1	1	(+)
2-day average	24	1	1	(+)
Avg on non-zero days	24	7	2	(+)
Variability	24	1	0	(+)
Annual max	24	2	0	(+)
Number of 99 th pct exceedances	24	5	0	(+)

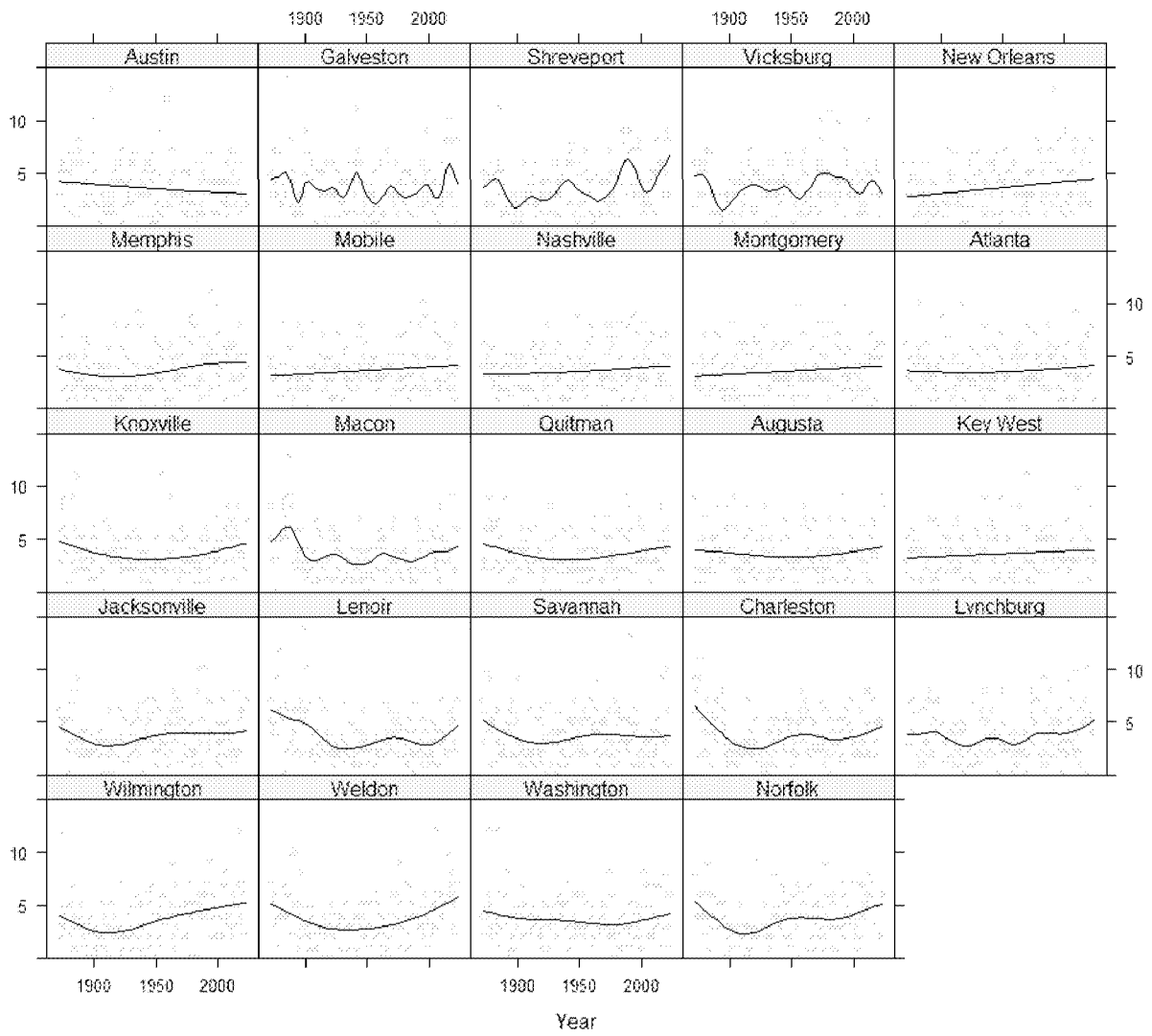
Since 1950:

	No. stns	+ trends	- trends	region
1-day average	24	5	0	++
2-day average	24	5	0	++
Avg on non-zero days	24	5	1	++
Variability	24	6	0	++
Annual max	24	4	0	++
Number of 99 th pct exceedances	24	4	0	(+)

Since 1980:

	No. stns	+ trends	- trends	region
1-day average	24	5	0	(+)
2-day average	24	5	0	(+)
Avg on non-zero days	24	5	1	(+)
Variability	24	3	0	(+)
Annual max	24	4	0	(+)
Number of 99 th pct exceedances	24	4	0	(+)

Annual No. 99th Percentile Exceedances SE 1873-2024



MIDWEST

Since 1893:

	No. stns	+ trends	- trends	region
1-day average	61	23	0	++
2-day average	61	23	0	++
Avg on non-zero days	61	2	12	(+)
Variability	61	12	0	++
Annual max	61	9	0	(+)
Number of 99 th pct exceedances	61	10	0	(+)

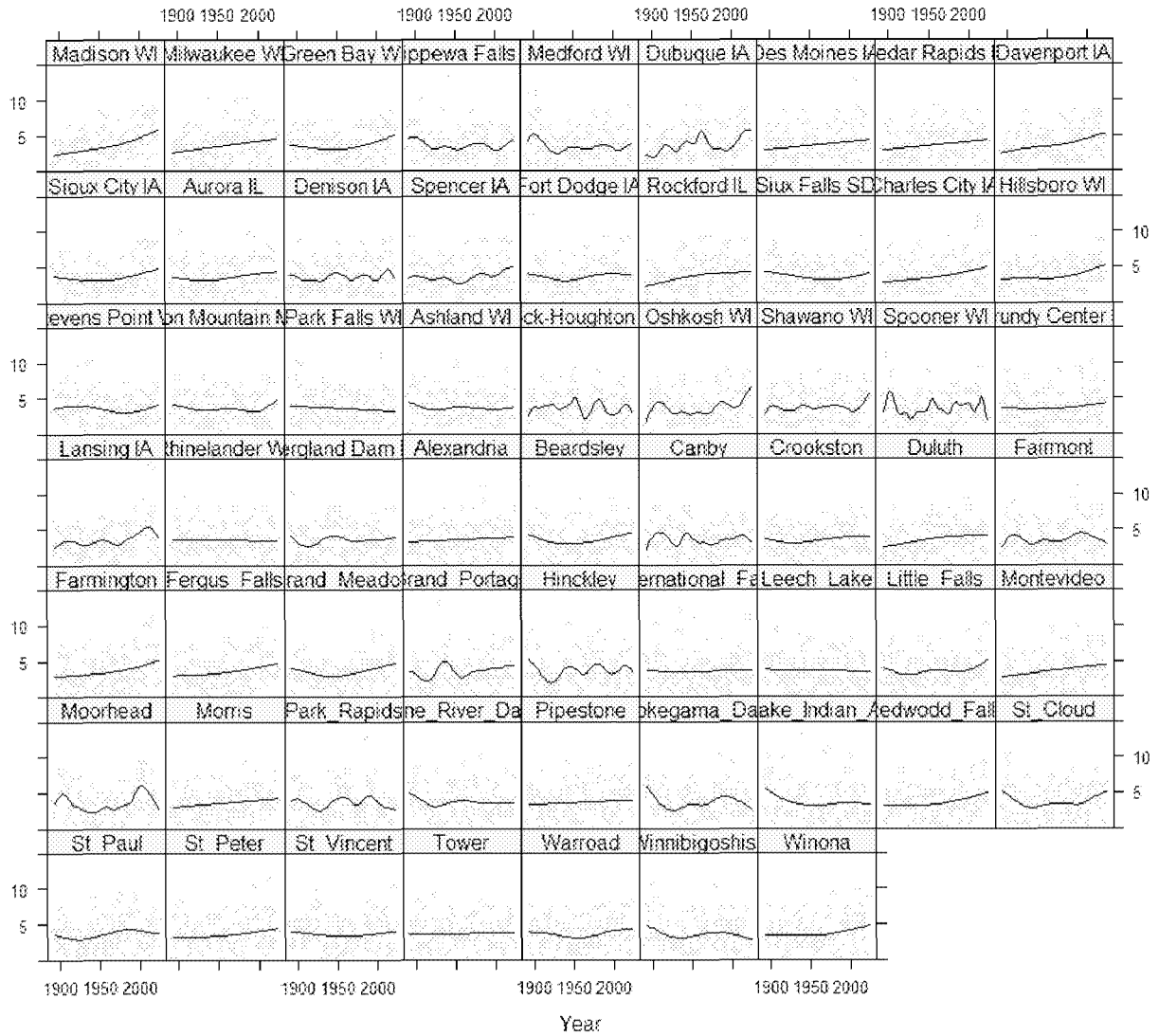
Since 1950:

	No. stns	+ trends	- trends	region
1-day average	61	28	2	++
2-day average	61	28	2	++
Avg on non-zero days	61	11	1	++
Variability	61	16	0	(+)
Annual max	61	8	0	(+)
Number of 99 th pct exceedances	61	19	0	++

Since 1980:

	No. stns	+ trends	- trends	region
1-day average	61	6	1	(+)
2-day average	61	6	1	(+)
Avg on non-zero days	61	8	2	(+)
Variability	61	5	1	(+)
Annual max	61	0	1	(+)
Number of 99 th pct exceedances	61	5	3	(-)

Annual No. 99th Percentile Exceedances MW 1893-2024



NORTHEAST

Since 1888:

	No. stns	+ trends	- trends	region
1-day average	27	12	0	++
2-day average	27	12	0	++
Avg on non-zero days	27	7	1	(+)
Variability	27	4	0	(+)
Annual max	27	3	0	(-)
Number of 99 th pct exceedances	27	5	0	(+)

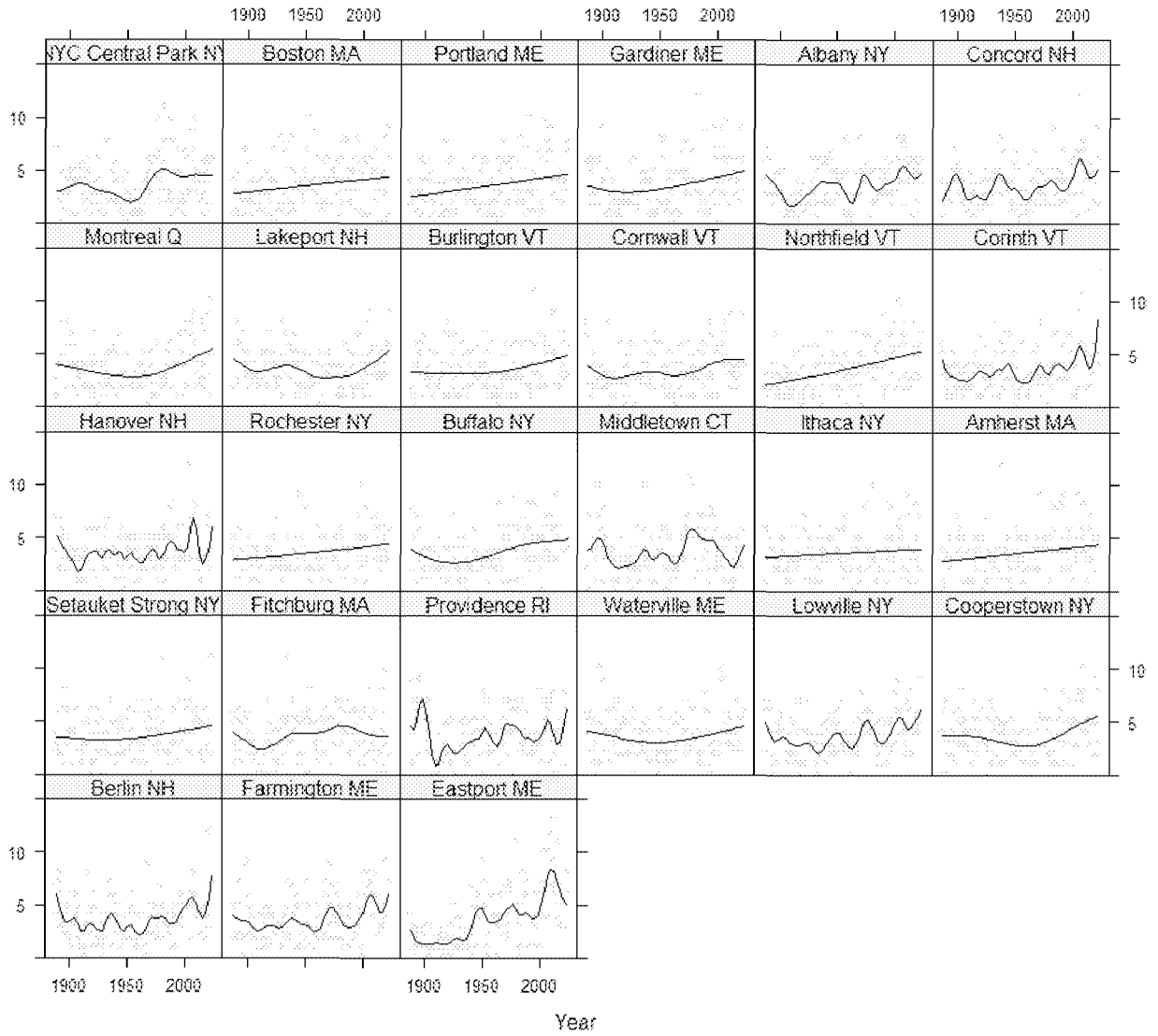
Since 1950:

	No. stns	+ trends	- trends	region
1-day average	27	12	0	++
2-day average	27	12	0	++
Avg on non-zero days	27	7	1	(+)
Variability	27	4	0	(+)
Annual max	27	3	0	(-)
Number of 99 th pct exceedances	27	5	0	++

Since 1980:

	No. stns	+ trends	- trends	region
1-day average	27	10	1	++
2-day average	27	10	1	++
Avg on non-zero days	27	6	0	(+)
Variability	27	2	0	(+)
Annual max	27	1	0	(+)
Number of 99 th pct exceedances	27	1	1	++

Annual No. 99th Percentile Exceedances NE 1888-2024



From: Ross McKittrick [ross.mckittrick@gmail.com]
Sent: 6/11/2025 10:47:48 PM
To: Judith Curry [curry.judith@gmail.com]; Roy W. Spencer [roywspencer@hotmail.com]; John Christy [climateman60@gmail.com]; Steven Koonin [steven.koonin@googlemail.com]; Travis Fisher [travis.scott.fisher@gmail.com]; Josh Loucks [loucksj14@gmail.com]
Subject: JUne 11 draft
Attachments: NCA5.Review.[RM].June11.docx

The attached incorporates all of Judy's suggestions including deletions and John's edits of Sect 4.2. I also dealt with Steve's various comments in the opening section as best I could. Did some additional editing, including adding in Roy's word search data. John you had suggested some additional text for the NCA4 magic ratio diagram but I think the example works best if we keep the writeup as simple as possible.

I am not sure Chapter 7 (biased references) is needed unless someone plans to write it up. I moved the discussion of the NASEM review to Ch 8. Do we have more material for that? Also I took out the review example from RPJr since I don't think we have documentation for it. it is a good one to keep in reserve though in case people want to wave peer review at us.

Review of the Fifth National Climate Assessment

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1 INTRODUCTION

1.1 About this Report

This report responds to a request from OSTP Director Michael Kratsios (reproduced in Appendix XX) that we assess the suitability of the Fifth National Climate Assessment for informing climate and energy policies.

To conduct this assessment we reviewed NCA5 itself, NASEM review of the Third Order Draft and the USGCRP responses to the review. We have drawn upon our long experience working on advisory reports, including for the NASEM, IPCC and other organizations, as writers, reviewers and project leaders.

Our report begins with background on the National Climate Assessments. We then discuss the standards by which we have assessed NCA5, followed by specific deficiencies that we have identified

We find that NCA5 should not be relied on for policy making as it is an incomplete and misleading picture of our understanding of the changing climate and the risks it poses to the nation. NCA5 was selective and incomplete in its survey of the science as of its publication date in 2023 and has become even more so in the years since. We have reviewed many key scientific developments in a separate report to Energy Secretary Wright (Climate Working Group 2025, herein denoted “CWG25”). The overall effect of the biases and omissions of NCA5 is an excessively dire picture of climate risk.

1.2 About the National Climate Assessments

The U.S. Global Change Research Program (USGCRP) was established by Presidential Initiative in 1989 and mandated by Congress in the Global Change Research Act (GCRA) of 1990 to develop and coordinate “a comprehensive and integrated United States research program which will assist the Nation and the world to understand, assess, predict, and respond to human-induced and natural processes of global change.”

The National Climate Assessment (NCA) Reports evolved from the GCRA requirement to

Prepare and submit to the President and the Congress an assessment which (1) integrates, evaluates, and interprets the findings of the Program and discusses the scientific uncertainties associated with such findings; (2) analyzes the effects of global change on the natural environment, agriculture, energy production and use, land and water resources, transportation, human health and welfare, human social systems, and biological diversity; and (3) analyzes current trends in global change, both human-induced and natural, and projects major trends for the subsequent 25 to 100 years.

The five NCA Reports to date have interpreted this mandate in different ways:

- NCA1 (2000) was a multidisciplinary effort to study and portray in regional detail the potential effects of human-induced global warming on the United States.
- NCA2 (2009) was a relatively short report that not only focused on the potential consequences of climate change, but also sought to identify potential adaptation measures and identify the highest priorities for future research.
- NCA3 (2014) was an expanded effort that continued along the lines of NCA2, and was distinguished by a comprehensive review process, including a review by the National

Academy of Sciences. NCA3 introduced a traceability analysis for each key finding, including a description of uncertainties.

- NCA4 (2017/2018) was an expanded effort published in two volumes: I Climate Science Special Report, and II Impacts, Risk, and Adaptation in the United States. This was the first NCA report to devote significant effort to assessing climate science.
- NCA5 (2023) returned to a single volume format, reducing discussion of climate science to a cursory two chapters, with continuing with a focus on regional and sectoral impacts of climate change. NCA5 expanded its remit to topics that are arguably outside the purview of the USGCRP, focusing on “Climate Action” and policy recommendations with a social justice emphasis. NCA5’s self-description is reproduced as Appendix II.

These successive interpretations of the NCA are poorly aligned with the GCRA’s statutory requirements. Only NCA4 gives serious consideration to climate science, which receives the great majority of USGCRP funding, and even then misrepresents some important points. Natural climate variability is essentially dismissed as unimportant in NCA4 and barely mentioned in NCA5 in most contexts, despite the mandate to include both human-caused and natural climate change. Most significantly, NCA5 has redirected the focus away from climate science and even the hazard elements of impacts, towards evaluation of societal vulnerabilities and advocacy for particular policy options, especially wind and solar power. The cover image for the NCA5 Report is the installation of a solar panel.

1.3 Standards for Assessing NCA Products

In Appendix XX we include a letter of guidance from the Office of General Counsel, U.S. Department of Energy, summarizing the extent of statutory requirements governing USGCRP work products in general and NCA products in particular.

We can summarize the standards applicable to the NCA as follows:

- details.

Beyond the statutory requirements we draw attention to two other pertinent standards. President Trump’s executive order of May 23, 2025, “Restoring Gold Standard Science” enumerates some of the characteristics of good science:

- i. reproducible;
- ii. transparent;
- iii. communicative of error and uncertainty;
- iv. collaborative and interdisciplinary;
- v. skeptical of its findings and assumptions;
- vi. structured for falsifiability of hypotheses;
- vii. subject to unbiased peer review;
- viii. accepting of negative results as positive outcomes; and
- ix. without conflicts of interest.

Although these should be self-evident to those trained in science, it is surprising that some have found them controversial.

When scientific reports are being assembled that will be highly influential on climate policymaking there are other desiderata, including statements about the strength of climate knowledge. The IPCC's approach is based on judgment of the available evidence and agreement among experts. More sophisticated knowledge characterizations for risk management include (Aven 2017)¹:

- The degree to which the assumptions made are reasonable/realistic based on background knowledge
- The degree to which data/information exists and are reliable and relevant
- The degree to which there is disagreement among experts (including those from different environments or academic fields)
- The degree to which the phenomena involved are understood and accurate models exist
- The degree to which the knowledge has been thoroughly examined with respect to unknown knowns

Good climate and energy policies will balance the risks and benefits of a changing climate against the world's growing demand for reliable and affordable energy. To strike that balance, policymakers must understand at least two complex and nuanced topics: the certainties and uncertainties of climate science and the technoeconomic realities of energy systems. Experts in those subjects have a unique responsibility to communicate their understanding to non-experts clearly, completely, and without bias.

Expertise in energy systems resides largely in the private sector, where it is essential to providing the reliable and affordable energy services that are the lifeblood of society. Understanding is therefore continually refined and tested by the discipline of the marketplace. In contrast, climate science expertise is found largely in the non-profit realm of universities and government laboratories and so has a more academic character.

In recent decades, climate science has engendered passion and emotion. Indeed, some younger climate scientists have gone into the field to "save the planet." So it is not surprising that objectivity can suffer when climate scientists communicate their understanding to non-experts. Further, the field of climate science has been politicized by NetZero mandates. This lack of objectivity usurps the public's right to make informed choices and undermines their confidence in the scientific enterprise.

Philip Handler, President of the National Academy of Sciences, identified the problem in a 1980 editorial² that resonates eerily four decades later:

Difficulty arises in the scientific community from confusion of the role of scientist *qua* scientist with that of scientist as citizen, confusion of the ethical code of the scientist with the obligation of the citizen, blurring the distinction between intrinsically scientific and intrinsically political questions. When scientists fail to recognize these boundaries, their own ideological beliefs, usually unspoken, easily becloud seemingly scientific debate.

¹ Aven, Terje (2017) "Improving Risk Characterisations in Practical Situations by Highlighting Knowledge Aspects, with Applications to Risk Matrices," *Reliability Engineering & System Safety* 167 (November 2017): 42–48 <https://www.sciencedirect.com/science/article/pii/S0951832016306950>

² Handler, Philip (1980) Public Doubts About Science. *Science* 208(4448) p. 1093 <https://www.science.org/doi/10.1126/science.208.4448.1093>

1.4 When Peer-Review Fails

Peer-review of reports like IPCC and NCA products is not a silver bullet that guarantees quality. The peer review process for these reports differs in some important respects from traditional peer review in academic journals. First, NCA reviewers self-select on a volunteer basis whether to provide comments and what parts of the report to read, whereas in academic journals Editors recruit reviewers and assign them to specific papers. There is no guarantee that any particular section of an NCA report was reviewed by anyone, let alone by someone with a different perspective than the authors. This is a problem with NCA and IPCC reports since over the years many potential reviewers have given up making the effort, because their input has systematically been ignored. Second, NCA authors have near complete authority whether to accept or reject review comments. Here, for example, is how a review comment critical of a section of the NCA5 draft was handled by the authors:

By contrast in academic journals the Editor mandates the author to respond and the reviewer gets to assess its adequacy. Once an NCA chapter author team has been selected publication of their work is guaranteed, whereas academic journals routinely reject papers if they do not pass review.

These points are important to bear in mind because some readers might dismiss any criticism of NCA products out of hand on the grounds that they were “peer reviewed”. But the test of a report is whether its contents are a valid representation of the available evidence. Here we give an example in which NCA4 gave prominence to a Figure that completely misrepresented the underlying data and which evaded peer review to do so. Further details can be found in Koonin (2024).

As we pointed out in CWG25 Section 6.3 the number of heat extremes in the U.S. peaked in the 1930s and has declined ever since. Considering cold and hot extremes together the U.S. the U.S. climate has become more moderate over time. NCA4’s Part I (Climate Science Special Report, CCSR) says (prominently and with *Very High Confidence*) on Page 19 of the Executive Summary:

There have been marked changes in temperature extremes across the contiguous United States. The number of high temperature records set in the past two decades far exceeds the number of low temperature records.

and offers this figure in support:

Record Warm Daily Temperatures Are Occurring More Often

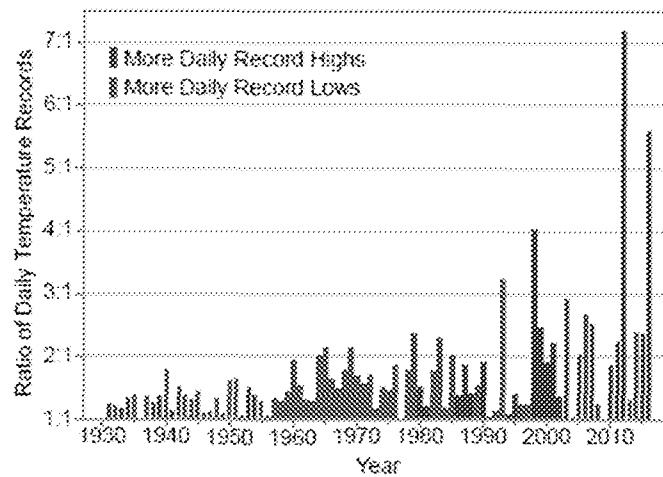
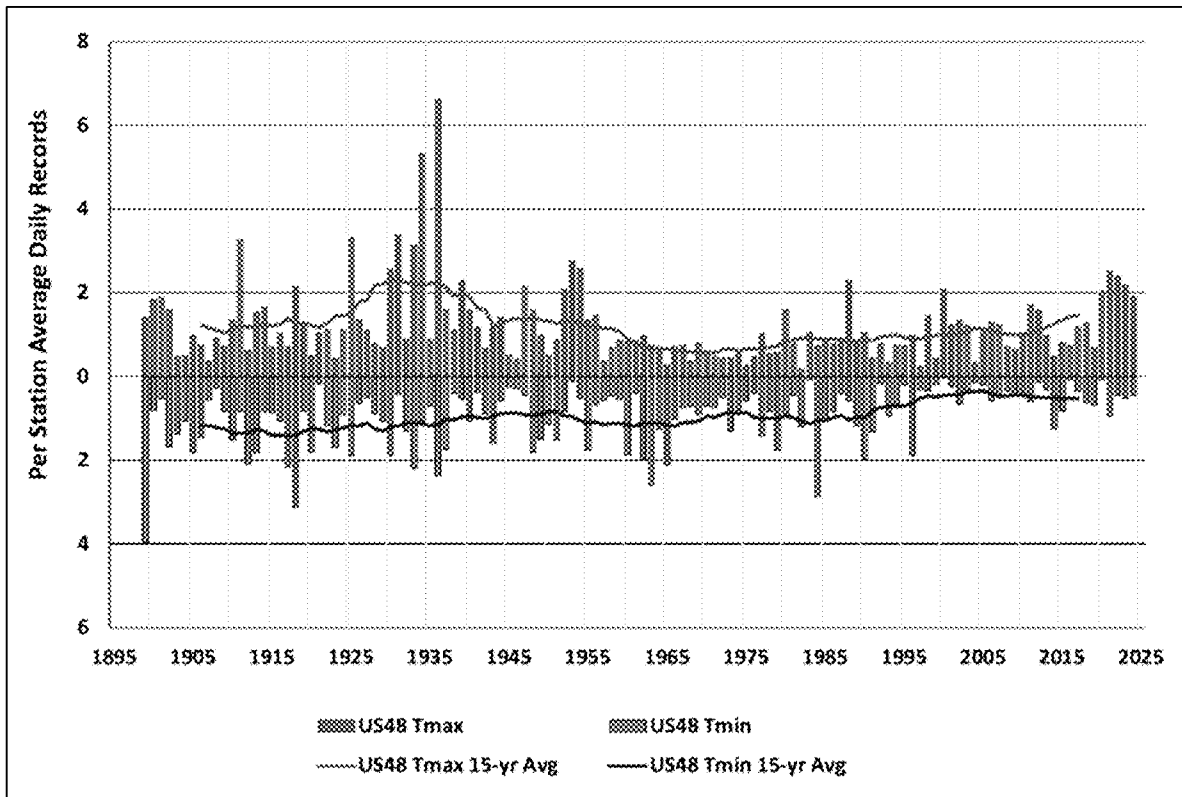


Figure ES.5: Observed changes in the occurrence of record-setting daily temperatures in the contiguous United States. Red bars indicate a year with more daily record highs than daily record lows, while blue bars indicate a year with more record lows than highs. The height of the bar indicates the ratio of record highs to lows (red) or of record lows to highs (blue). For example, a ratio of 2:1 for a blue bar means that there were twice as many record daily lows as daily record highs that year. (Figure source: NOAA/NCEI). From Figure 6.5 in Chapter 6.

The Figure appears to validate the claim that record warm daily temperatures are occurring more often. But the underlying data do not: they show that extreme heat in the U.S. peaked in the 1920s and 1930s and declined thereafter, as NCA4 Figure 6.4 later shows. Figure ES.5 does not show what its title implies: these are not simple counts of cold and warm extreme events; instead they are ratios of the two. In fact both types of extremes declined over the sample interval, but cold events declined more than warm events, so the ratio of warm extremes to cold extremes increased. By graphing the ratio in this way the NCA4 created a visual impression opposite to what is in the data.

Figure 6.3.3 of CWG25 (reproduced below) shows the results of a proper analysis of the data – defining each record as the singular extreme in the history, displaying numbers of warm and cold records separately, and beginning the analysis in 1899 rather than 1930. It makes evident the exceptional heat of the 1920s and especially the 1930s, peaking in 1936. The increased heat of the past five years is too brief to be deemed climatically significant and, in any event, occurred after the CSSR was published in 2017. The frequency of cold records has declined, especially over the last quarter of the period in which only 13 percent of the extreme cold events were measured. In contrast, 25 percent of the extreme Tmax records were achieved in the last quarter, which is consistent with statistical expectations. As a result, the ratio of heat to cold extremes shown in Figure ES.5 of the CSSR explodes in recent decades. The overall reduction in numbers of both cold and hot extremes over the past century indicates a climate *less* prone to extremes, in sharp contrast to the message of the NCA4 Figure ES.5.



Number of daily record High (red) and Low (blue) temperatures for warm and cold seasons in the CONUS. The lines represent the 15-year running, centered average. Source: 1,211 USHCN stations supplemented as needed to achieve a minimum of 92 percent of observations in the 126-year period since Dec 1898. US48: contiguous U.S. states. Tmax: maximum temperature. Tmin: minimum temperature. Source: CWG25 Figure 6.3.3.

The National Academies' expert review panel criticized the discussion of temperature extremes in a late draft of the CSSR. In reference to the CSSR's Key Finding 2 of Chapter 6, they said:

Further, it is difficult to understand how a statement that includes increases in extreme warmth can be associated with a high confidence or extremely likely statement, given that most of the graphics in this chapter show a decrease in extreme warmth in the historical record.

The Federal official in charge of the CSSR (Michael Kuperberg, Executive Director of the USGCRP) responded to the Academies' review by noting that

Almost every recommendation from the NAS was incorporated [in the final version]... and a new figure was added on changes in record high and low temperatures

The "new figure" referred to is the Figure ES.5, which did not appear in the draft reviewed by the Academies' panel. It seems unlikely that the Academies panel ever saw that figure because they surely would have commented if they had and it wouldn't have survived to publication. And the figure's problems were evidently not flagged (or were ignored) in the subsequent internal government reviews.

With this background we now present our critique of NCA5.

2 NCA5 OVERVIEW CHAPTER: HYPERBOLIC ADVOCACY LANGUAGE AND NON-SCIENTIFIC TONE

NCA5 Chapter 1 “Overview” holds a prominent place in the Report since it summarizes the whole report and is the only section that many will read. Although the later Chapters of NCA5 contain much sound scholarly content, Chapter 1 is marred by a pervasive tone and language that aggressively promotes emission reduction policies. As such, this chapter adds an imprimatur of scientific authority to oversimplified declarations of opinion about public policy. Here we cite a few examples that are particularly egregious.

Chapter 1 opens as follows:

The more the planet warms, the greater the impacts. Without rapid and deep reductions in global greenhouse gas emissions from human activities, the risks of accelerating sea level rise, intensifying extreme weather, and other harmful climate impacts will continue to grow. Each additional increment of warming is expected to lead to more damage and greater economic losses compared to previous increments of warming, while the risk of catastrophic or unforeseen consequences also increases.

This statement presupposes that: all warming is anthropogenic in origin, all warming is bad and causes economic damage, warming causes extreme weather to intensify. Such sweeping generalizations go well beyond what science has or can establish. It also refers to growing risks without saying whether they were large to begin with: a small risk that grows may still be a small risk. A scientifically-sound version of this paragraph would instead say something like the following:

The Earth is warming because of a combination of natural and anthropogenic influences. This warming will generate a mix of benefits and harms that varies by region, to which society should be prepared to adapt. Some types of extreme weather have worsened recently, while others have not changed or have even declined in intensity. Reducing emissions of greenhouse gases might slow the warming although such policies have proven to be costly and disruptive, so any climate actions to be weighed against the potential benefits.

On the next page the Overview goes on to say:

Each additional increment of warming leads to greater risks [here it lists 7 key components of society including food security and the economy]... Without deeper cuts in global net emissions, climate risks to the US will continue to grow... Action to limit future warming and reduce risks can have near-term benefits and opportunities: low-carbon energy jobs, Improved air quality, Health benefits, Economic benefits...”

The authors write as if climate policy does not involve trade-offs and all measures to reduce future warming will be effective and beneficial. But the vast body of scholarship on climate science and economics does not support such simplistic claims. Not every additional increment of warming leads to economic harms, indeed (as is acknowledged in Chapter 19 on Economics) in some cases there will be benefits. Nor is climate policy guaranteed to create jobs or benefit the economy; in many cases it has done the opposite. Such deceit is a disservice to policymakers.

Pages 8 and 9 promote renewable energy options by noting, correctly, that the levelized costs of wind/solar generation have fallen sharply since 2010. This is proposed as rationale for pursuing deep emission reductions:

Recent growth in the capacities of wind, solar, and battery storage technologies is supported by rapidly falling costs of zero- and low-carbon energy technologies, which can support even deeper emissions reductions. For example, wind and solar energy costs dropped 70% and 90%, respectively, over the last decade, while 80% of new generation capacity in 2020 came from renewable sources.

Yet it has long been known that intermittent renewables generation must be supplemented by dispatchable generation to meet grid reliability standards, and that doing so (e.g., through natural gas, fission, or storage) can substantially increase the cost of electricity. Further, there are yet unmet synchronization challenges in transmission grids with heavy penetration of wind and solar power. Here again it is advisory malpractice not to acknowledge these facts.

Page 14 presents future emission scenarios with the following description: “Climate modeling experts develop global climate projections for a range of plausible futures.” The word “plausible” is applied to all the scenarios. The accompanying Figure includes both SSP3-7.0 and SSP5-8.5, the latter reaching the same radiative forcing as RCP8.5. The figure does not contrast observed emissions against previous projections nor does it caution readers that SSP3-7.0 and SSP5-8.5 are extreme worst case scenarios that, like RCP8.5, have been heavily criticized in the scientific literature (CWG25 3.2.1). By describing the entire envelope of emission projections as “plausible” the report opens the door to later presenting impacts associated with extreme and implausible emission scenarios as part of a baseline “business-as-usual” future.

Page 17 introduces the discussion of risks from extreme weather events by saying “Harmful impacts from more frequent and severe extremes are increasing across the country.” This creates the impression that disaster losses are driven by trends in extreme weather. While the section goes on to acknowledge that some of the increase is due to increases in the value of assets at risk it then invokes the NOAA Billion Dollar Dataset as evidence of extreme weather getting worse. Scientists have shown that this is an invalid metric (CWG 10.2) since it measures the growth of the economy not the frequency of extreme weather, and indeed NOAA has recently withdrawn the data product. Even though it was still distributed by NOAA at the time of the NCA5, the report authors should have assessed it skeptically and seen that it was unfit for the purpose of measuring climate trends and they should have taken care not to conflate extreme weather metrics with economic trends.

Page 23 states, in large font:

Climate changes are making it harder to maintain safe homes and healthy families; reliable public services; a sustainable economy; thriving ecosystems, cultures, and traditions; and strong communities.

It is pointless to try to evaluate this statement on scholarly grounds; it is self-evidently hyperbolic. This kind of language doesn’t belong in a scientific assessment report. Its prominent inclusion points not only to the willingness of NCA5 authors to promote hysteria, but also the ineffectiveness of the review process at not ensuring such statements are removed.

The tone of the Overview chapter hints at the priorities that governed the writing of the report as a whole. As a crude indicator of these priorities, word searches of the full document revealed the following occurrences:

Term	Number of occurrences
Forcing	111
Uncertainty	384
Watts	19
Culture/culturally	854
Equity/equitable	572
Indigenous	890
Sustainable	295
Racism/racial	153

3 OVERCONFIDENCE WHEN STATING CONCLUSIONS

3.1 Inflated certainty levels

A general pattern in the NCA5 is overconfidence in stating conclusions. The authors frequently make sweeping generalizations without appropriate caveats or acknowledging uncertainties. The overconfidence begins with inflated language to describe certainty levels.

The NCA5 uses specific terms to convey information about scientific confidence associated with important finds, observations and projections. The Front Matter of the NCA5 states that “confidence in a finding is based on the type, amount, quality, strength, and consistency of evidence; the skill, range, and consistency of methods to detect, evaluate, attribute, and interpret climate trends; and the degree of agreement across scientific information sources.”

Table 1 from the Front Matter provides calibrated language for confidence assessment:

Very high:	Strong evidence (established theory, multiple sources, well documented and accepted methods, etc.). High consensus
High:	Moderate evidence (several sources, some consistency, methods vary and/or documentation limited, etc.). Medium consensus
Medium:	Suggestive evidence (a few sources, limited consistency, methods emerging, etc.) Competing schools of thought.
Low:	Inconclusive evidence (limited sources, extrapolations, inconsistent findings, poor documentation and/or methods not tested, etc.). Disagreement or lack of opinions among experts.

This terminology is inflated: *high confidence* with just moderate evidence and medium consensus; *medium confidence* with only suggestive evidence and competing schools of thought. This inflation in terminology leads to overconfidence in the conclusions.

Even within the context of this inflated terminology, NCA5 further inflates the confidence level of many of its conclusions to well beyond what the IPCC has concluded with more thorough justification, and also by incorrectly applying its own standards. Several illustrative examples are provided.

Key Message 3.1 Traceable Account states: “There is *very high confidence* that emissions of GHGs from human activities, fossil fuel use in particular, have unequivocally caused *all* global warming observed over the industrial era.” Compare this statement with statements from the IPCC AR5 and AR6:

AR5: “It is *extremely likely* that *more than half* of the observed increase in global average surface temperature from 1951 to 2010 was caused by the anthropogenic increase in greenhouse gas concentrations and other anthropogenic forcings together.” (IPCC, 2013)

AR6: “The *likely* range of total human-caused global surface temperature increase from 1850–1900 to 2010–2019 is 0.8°C to 1.3°C, with a best estimate of 1.07°C. It is *likely* that well-mixed GHGs contributed a warming of 1.0°C to 2.0°C, other human drivers (principally aerosols) contributed a cooling of 0.0°C to 0.8°C, natural drivers changed global surface temperature by –0.1°C to +0.1°C, and internal variability changed it by –0.2°C to +0.2°C. It is *very likely* that well-mixed GHGs were the main driver of tropospheric warming since 1979.” (IPCC, 2021)

The IPCC AR5 and AR6 statements provide likelihood assessments but not a confidence level. While the NCA5 claims with *very high confidence* that fossil fuels have unequivocally caused *all* global warming, the AR5 refers to “*more than half* of the observed warming” and the AR6 provides a more nuanced statement that relates to a *likely* range of warming contributed to by human drivers.

NCA5 Key message 2.2: “Hurricanes have been intensifying more rapidly since the 1980s (*high confidence*) and causing heavier rainfall and higher storm surges (*high confidence*).” No justification is provided in Chapter 2 for the *high confidence* conclusion on higher storm surges or hurricanes causing heavier precipitation. The Traceable Accounts section, Description of Confidence and Likelihood states: “Basic physical understanding and climate models both provide robust explanations for the links between climate change and observed changes in these extremes: this is why the authors also have *high confidence* that storms are delivering more rainfall and high confidence that storm surges are becoming higher.” In short, the NCA5 provides no observational basis or published research for their *high confidence* assertions that hurricanes are causing heavier rainfall and higher storm surges; and does not meet its own standards for a *high confidence level*.

3.2 Overstating findings in underlying sources

Although we did not do a detailed audit of the NCA5’s use of source material, spot checks turned up evidence of a pattern of overstatement.

Chapter 2 page 11 reports on an increase in precipitation in some areas and attributes it to climate change:

Many eastern regions of the country are getting wetter (Figure 2.4). Average annual precipitation from 2002-2021 was 5%-15% higher relative to the 1901-1960 average in the central and eastern US, a trend attributable to climate change.

Note that this a non-standard metric; we will discuss NCA5's inconsistent choices of time scales of analysis below. The claims were attributed to the following paper:

- Knutson, Thomas and Fanrong Zeng (2018) "Model Assessment of Observed Precipitation Trends over Land Regions: Detectable Human Influences and Possible Low Bias in Model Trends" *Journal of Climate* 31(12)
<https://journals.ametsoc.org/view/journals/clim/31/12/jcli-d-17-0672.1.xml>

But Knutson and Zeng did not say these things. They examined linear trends over 1901 – 2010, 1951 – 2010 and 1981 – 2010. They did not compare average rainfall over 2002 - 2021 to average rainfall over 1901 – 1960, indeed their study was published in 2018 so it could not have. With regard to 1981-2010 trends they noted stronger trends in some areas but cautioned that such changes are consistent with natural variability, and they did not claim attributable trends were observed over the United States:

Observed annual precipitation trends over the recent 30-yr period 1981–2010 (Fig. 5) have generally stronger magnitudes (in mm yr⁻¹ decade⁻¹) than observed trends for 1901–2010 or 1951–2010. This is as expected since trends over a shorter period have stronger potential for occurrence of pronounced temporary trends due to internal variability alone. Only 9% of the analyzed area has detectable and attributable anthropogenic influence (categories –3, –2, +2, +3), which represents less than one-third of the fractional areal coverage of such trends for 1901–2010 (29%). ... Eight percent of the analyzed area has attributable anthropogenic *increases* (categories +2, +3), including parts of eastern Europe, northern Asia, northern Australia/Maritime Continent, and tropical Africa.

Consider a 2nd example. NCA5 Chapter 2 page 18 states

There is robust evidence that human-caused warming has contributed to increases in the frequency and severity of the heaviest precipitation events across nearly 70% of the US.

This is attributed to two papers:

- Diffenbaugh, N.S., D. Singh, and J.S. Mankin, 2018: Unprecedented climate events: Historical changes, aspirational targets, and national commitments. *Science Advances*, **4** (2), 3354. <https://doi.org/10.1126/sciadv.aao3354>
- Kirchmeier-Young, M.C. and X. Zhang, 2020: Human influence has intensified extreme precipitation in North America. *Proceedings of the National Academy of Sciences of the United States of America*, **117** (24), 13308-13313. <https://doi.org/10.1073/pnas.1921628117>

Diffenbaugh et al. presented ratios of observed occurrences of extreme events to simulated occurrence rates in CMIP6 models run with only natural forcings. They report that for 79% of the U.S. extreme rainfall event frequencies are currently higher than in model simulations, and the ratio of occurrences will rise under future warming simulations. This is not "robust" evidence of anthropogenic influence since it requires readers to assume that climate models provide accurate

simulations of regional precipitation patterns, something which even the IPCC AR6 admits is uncertain (AR6 WGI SPM Box SPM 1.2, SPM Section C.1.3).

Kirchmeier-Young and Zhang looked at extreme 1- and 5-day events in North America and, using 3 GCMs, found “A signal of combined anthropogenic and natural external forcing can be detected in the intensification of extreme precipitation at the continental scale over North America. In some cases, this intensification can be attributed to human influence specifically.” However, they noted large differences among the three models in their simulated precipitation changes. Also, 2 of the 3 models failed to yield detection for 5-day events for the North America mean. Both cited references utilized the implausible RCP8.5 scenario and began their “historical” observational records only in 1961. Here again this is not “robust” evidence, it is suggestive but other studies have found natural variability predominant.

4 RELIANCE ON *Ad Hoc* TIME SCALES FOR TREND ANALYSIS

In CWG25 Chapter 6 we discussed the need to be careful regarding the choice of time scale when making claims about trends in extreme weather. We gave examples from analysis of river flooding (6.1), heatwaves (6.3) and extreme precipitation (6.4) to show how assertions about apparent trends based on short data sets fall apart when looking at longer versions of the same data sets. Here we elaborate on these examples to illustrate a general point that NCA5 made inconsistent and *ad hoc* choices about time scales of analysis, weakening the validity of their conclusions.

McKittrick and Christy (2019)³ showed that apparently significant positive trends in U.S. average and extreme precipitation over the NCA4 interval (1901 – 2016) disappeared on longer samples (extending back as far as the 1840s depending on location) or on a shorter interval coinciding with the final 40 years of the data then available (1978 – 2017).

In CWG Section 6.4 we presented analysis of updated data for the same locations and many more besides, in all cases finding considerable regional heterogeneity and lack of robustness of trends to use of long samples.

4.1 Average and Extreme Precipitation

Under Key Message 2.2 “Extreme Events Are Becoming More Frequent and Severe” (p. 2-16) NCA5 states (p. 2-18):

Rainfall is becoming more extreme

Since the 1950s, there has been an upward trend in heavy precipitation across the contiguous US. This increase is driven largely by more frequent precipitation extremes, with relatively smaller changes in their intensity.

NCA5 did not continue the NCA4 precedent of using the post-1901 interval as the time scale for its precipitation discussion, instead it refers to changes “since the 1950s”. Fig. 2.8 suggests 1958 as the start date. For the present report we have extended the CWG25 analysis even further to include 141 stations across the US in the Pacific Coast, Midwest, Northeast and Southeast regions. We provide details in the Appendix; here we note merely that once again it is possible to find trends that support the NCA5 position, but they are not robust to selecting longer or shorter time scales of analysis. Data from 1950 to 2024 yields many indications of increased average and extreme precipitation at individual stations and region-wide averages. But when using the entire data set (back to the 1890s or earlier depending on location) or the later subset (1980 to 2024) the trends become smaller, in many cases they become statistically insignificant, and occasionally they change sign. Only in the Northeast region are the post-1950 trends robust to also focusing on the post-1980 interval.

The following is a more accurate summary of what U.S. data show.

³ McKittrick, R., and J.R. Christy (2019). Assessing changes in US regional precipitation on multiple time scales. *Journal of Hydrology*, 578, 124074. <https://doi.org/10.1016/j.jhydrol.2019.124074>

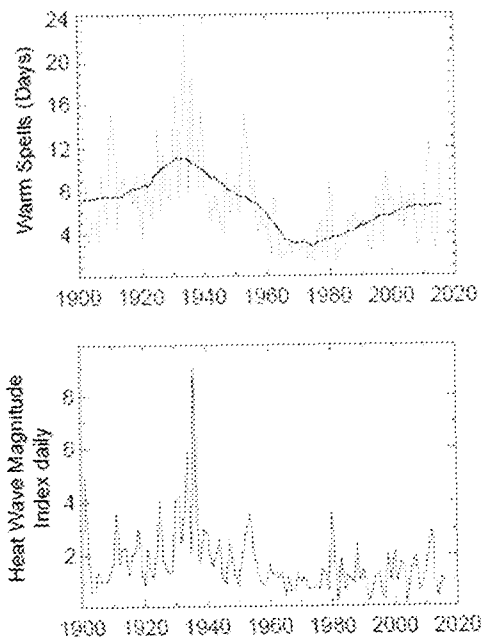
There are regionally-heterogenous changes in average and extreme precipitation. Positive trends in annual average rainfall and extreme events (defined either as the annual maximum or the number of exceedances of the 99th percentile value) are generally weak or non-existent when looking at samples exceeding 130 years in length. Significant trends can be found when beginning the sample in the 1950s although in most cases the trends weaken and become insignificant when looking at the post-1980 interval. This makes attribution to anthropogenic warming difficult.

4.2 Heatwaves

In contrast to NCA5, NCA4 examined heat extremes across the whole of the 20th century, pointing out that peak heat wave activity was reached in the 1930s and has decreased since then, and that recent increases are confined to areas west of the Rockies:

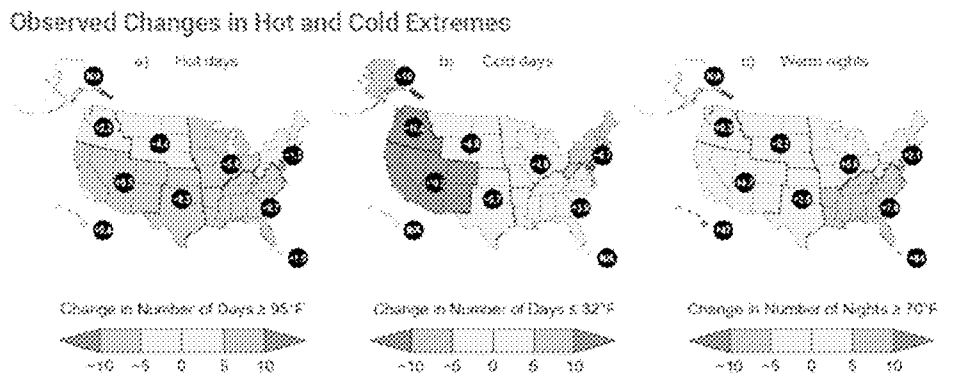
[The] warmest daily temperature of the year increased in some parts of the West over the past century, but there were decreases in almost all locations east of the Rocky Mountains. In fact, all eastern regions experienced a net decrease, most notably the Midwest (about 2.2°F [1.2°C]) and the Southeast (roughly 1.5°F [0.8°C]).

Since the mid-1960s, there has been only a very slight increase in the warmest daily temperature of the year (amidst large interannual variability). Heat waves (6-day periods with a maximum temperature above the 90th percentile for 1961–1990) increased in frequency until the mid-1930s, became considerably less common through the mid-1960s, and increased in frequency again thereafter. As with warm daily temperatures, heat wave magnitude reached a maximum in the 1930s. (NCA4 pp. 190-191)



U.S. Heat waves since 1900. Source: NCA4 Figure 6.4

Contrast this careful and factual language with NCA5 Key Message 2.2: “Extreme Events Are Becoming More frequent and Severe.” This blanket statement is followed by NCA5 Figure 2.7 reproduced below.



Hot days have increased in the West, hot nights have increased nearly everywhere, and cold days have decreased.

Figure 2.7. Over much of the country, the risk of warm nights has increased while the risk of cold days has decreased. The risk of hot days has also increased across the western US. This figure shows the observed change in the number of (a) hot days (days at or above 95°F), (b) cold days (days at or below 32°F), and (c) warm nights (nights at or above 70°F) over the period 2002–2021 relative to 1901–1960 (1951–1980 for Alaska and Hawaii and 1956–1980 for Puerto Rico). Data were not available for the US-Affiliated Pacific Islands and the US Virgin Islands. Figure credit: Project Drawdown, Washington State University Vancouver, NOAA NCIE, and CISSS NC.

Close inspection shows that this Figure contradicts the NCA5 Key Message with respect to heatwaves and instead reinforces the position of the NCA4. The time scale of analysis for this Figure is stated as the number of hot days, cold days and warm nights (respectively in panels a—c) over the period 2002-2021 compared to 1901-1960. Presumably (though not stated in the caption) the counts are per year. Notwithstanding Key Message 2.2 the leftmost panel shows that over most of CONUS the number of extreme heat days has decreased in recent decades compared to the prior century.

The accompanying discussion in NCA5 becomes convoluted since it appears to be aimed at supporting the Key Message despite the contrary evidence. NCA5 chapter 2 elaborates on KM2.2 by saying (p. 16):

Observations show an increase in the severity, extent, and/or frequency of multiple types of extreme events. Heatwaves have become more common and severe in the West since the 1980s (*high confidence*).

But it does not mention the decline elsewhere. On the next page (p. 17) it says:

By some measures, the most extreme heatwaves on record in the United States occurred during the Dust Bowl era of the 1930s. ... Globally such heatwaves are becoming more frequent, and in recent decades the western United States has been following those trends.

Reference to a global trend seems to be an attempt to tie heatwaves to climate change, but then the obvious question, unaddressed by NCA5, is why only part of the U.S. follows it while most of the

country is trending in the opposite direction. These issues were addressed in CWG25 Ch6, demonstrating that the range and magnitude of extreme temperatures (10s of degrees) are driven more by natural variability than the small extra forcing from the enhanced concentrations of CO₂. The data shown in CWG25 shows that in terms of both (a) hot days ($\geq 95^{\circ}\text{F}$) and (b) number of days in heatwaves, the current decade is experiencing no more than was experienced 100 years ago. For example, in the 30-year period 1925-1954, representing only 23% of the 1899-2024 data record, the CONUS experienced 33% of the total heat wave days. The most recent 30-years experienced 24%, almost exactly that expected by chance. Thus, the NCA5 claim that “multiday heatwaves have become hotter, more frequent, larger, and longer lasting in recent decades,” is seen to be simply false when expanding the temporal and spatial domains to encompass all available data (Ch6 Fig. 6.3.6 CWG25).

The NCA5 then pointed to the dramatic Pacific Northwest heatwave of 2021. CWG Section 8.6.1 discussed this event in detail, reviewing the findings of multiple peer-reviewed studies that explained the unusual meteorological conditions giving rise to it were unrelated to climate change, a point omitted from the NCA5 discussion.

NCA5 finally turns to the declining heatwave trend in CONUS east of the Rockies but attempts to reframe it by focusing on urban warm spells.

[The] number of very hot days has actually decreased across the central and eastern regions due to summer cooling trends in the region (Figure 2.7; Ch. 22). This does not, however, mean the central and eastern US are not affected by heat. The impacts of extreme high temperatures are more severe if such conditions persist for several days, and overall, multiday heatwaves have become hotter, more frequent, larger, and longer lasting in recent decades. Across 50 large US cities, the US Global Change Research Program heatwave indicator (<https://www.globalchange.gov/indicators/heat-waves>) shows that the average number of heatwaves has doubled since the 1980s, and the length of the heatwave season has increased from about 40 days to about 70 days.

We discussed this issue in CWG25 Section 6.3. The Figure referenced by NCA5 uses an *ad hoc* definition of heat wave, namely two consecutive days with minimum nighttime temperatures above the 85th percentile, and an *ad hoc* time scale which begins in the 1960s, the coldest decade in the last century, thus suppressing any comparison to the 1930s. Nighttime temperatures in urban areas have gone up faster than daytime temperatures (which the NCA5 acknowledges), but this is a signature of urban heat island effects and is not a good metric of climate change. CWG25 noted as well that the occurrence of hot days ($\geq 95^{\circ}\text{F}$) has recently increased in the West, but declined in the remainder of the country, and in the nationwide average, since 1899.

5 INADEQUATE TRACEABLE ACCOUNTS

Starting with the NCA3, the NCA has included a section on Traceable Accounts at the end of each Chapter. This is the description from the NCA5:

Each chapter concludes with a section entitled Traceable Accounts, which provides information on the overall process used to develop the chapter as well as a separate Traceable Account section for each Key Message. These Traceable Accounts describe the supporting evidence behind each Key Message, the process and rationale authors used in reaching their conclusions, and the author team's expert assessment of the confidence in and, where applicable, likelihood of these conclusions. As such, Traceable Accounts provide information about the state of the science, document sources of uncertainty, identify research gaps, and allow traceability to data and resources.

The Traceable Accounts for each Chapter and Key Message includes the following sections:

- Description of Evidence Base
- Major Uncertainties and Research Gaps
- Description of Confidence and Likelihood

The Traceable Accounts are in principle an important factor in addressing the NCA's statutory requirement to discuss scientific uncertainties. Further, the Traceable Accounts can help satisfy the Executive Order for Restoring Gold Standard Science with regards to: reproducibility, transparency, communication of error and uncertainty, and skepticism of findings and assumptions. However, the execution of the Traceable Accounts is uneven, often superficial and noninformative in Chapters 2 and 3 (which were the only Chapters investigated here). Here is an example from Key Message 2.2: Extreme Events are Becoming More Frequent and Severe.

Description of the Evidence Base consists of two paragraphs, with the first paragraph summarizing the findings and the second paragraph providing a generic description of the types of data that can be used for storms. Major Uncertainties and Research Gaps focuses on the uneven distribution across US populations due to differences in exposure and vulnerability. The only limitations in data referred to are the lack of a long-term record of lightning, and the lack of homogenized daily and hourly temperature data except from reanalysis products.

The most astonishing deficiency is in the Description of Confidence and Likelihood. One of the statements in Key Message 2.2 is: "Hurricanes have been intensifying more rapidly since the 1980s (high confidence) and causing heavier rainfall and higher storm surges (high confidence)." The Description of Confidence and Likelihood includes the following statement: "Basic physical understanding and climate models both provide robust explanations for the links between climate change and observed changes in these extremes: this is why the authors also have high confidence that storms are delivering more rainfall and high confidence that storm surges are becoming higher." No reference to journal publications or a specific data set is made in the Chapter regarding hurricane induced precipitation or storm surge to support this *high confidence* conclusion.

With regards to Chapter 3, there are some substantial inconsistencies between the Traceable Accounts for the different Key Findings:

Key Message 3-1: Human activities have caused global warming.

Confidence and Likelihood: “There is *very high confidence* that emissions of GHGs from human activities, fossil fuel use in particular, have *unequivocally* caused all global warming observed over the industrial era. There is also *very high confidence* that changes in natural climate drivers have had globally small and regionally variable long-term effects over this period.”

The Uncertainties section only addresses uncertainties in radiative forcing of greenhouse gases. By contrast, consider Key Message 3-4: Humans are changing Earth System processes. The Traceability Analysis in this section contains arguably the most scientifically credible text in the entire Chapter. From Description of Evidence Base: “In the last decade, there has been increasing recognition of the role of regional-scale natural variability in the past and future evolution of climate, as well as the fact that regional natural variability signals can be competitive with forced anthropogenic signals”. From Major Uncertainties and Research Gaps: “For example, the true natural variability of the climate system on decadal to centennial timescales could be larger than what we estimate from GCMs, which would further increase the irreducible uncertainty stemming from natural variability.”

As part of the Traceable Account: “Each figure and some tables are accompanied by a metadata survey, which can be accessed in the online version of the report by clicking on the eyeball icon above the figure or table (see the table below for explanations of additional icons used throughout the report). The metadata survey describes data sources, figure or table development methods, copyright information, and other important documentation.” Upon clicking on the eyeball icon above a particular figure, a Contact US email appears, addressed to the USGCRP. No attempt was made to send a email to elicit the Metadata information, but it is clear that this information is not readily accessible online.

In summary, the Traceable Analyses examined here, with few exceptions, fail to meet the stated objectives set forward by the NCA.

6 OVEREMPHASIS ON EXTREME SCENARIOS

To respond to the GCRA mandate to “project major trends for the subsequent 25 to 100 years,” the NCA relies on projections of future climate change based on estimates of future emissions (the so-called SSP scenarios) and/or specified levels of radiative forcing (the RCP scenarios). For the most part, NCA5 uses scenarios developed for the IPCC Assessment Reports.

In CWG Section 3.2.1 we presented a critical assessment of past and current IPCC scenario envelopes, showing that they have tended to overshoot observed emissions. The IPCC AR6 published in 2021 stated that “The likelihood of high-emission scenarios like RCP8.5 and SSP5-8.5 is considered low in light of recent energy sector developments.” In 2021, UN Climate Negotiators (COP) stopped using scenarios above 4.5. NCA5 makes the following observations about the scenarios they use:

“NCA5 authors were advised to assess the full range of scenarios available.” (Front Matter)

“Scenarios of future emissions and land-use change are developed as plausible alternatives, but no relative likelihood is attached to them. Some recent studies, however, have argued that the highest scenario, SSP5-8.5, is no longer plausible without a reversal of current trends in the adoption of renewables and energy efficiency.” (Key Message 3.3 Traceable Analysis)

Despite acknowledging the issue the NCA5 otherwise ignored the problem. A keyword search of the NCA5 of mentions of RCP/SSP scenarios finds over 50% referred to the extreme emissions scenarios RCP8.5/SSP5-8.5. Further, 10 figures *only* included the 8.5 scenarios: 5.2, 6.9, 7.4, 11.3, 14.6, 22.13, 22.19, 27.9, 29.13.

The problem of relying on extreme scenarios is particularly acute for NCA5’s sea level rise projections. The sea level rise scenarios used in the NCA5 do not relate directly to the SSP emissions scenarios, but to specified amounts of sea level rise by 2100, whereby Low relates to 0.3 m (0.98 feet), Intermediate-Low relates to 0.5 m (1.64 feet), Intermediate relates to 1.0 m (3.28 feet), Intermediate-High relates to 1.5 m (4.92 feet), and High relates to 2.0 m (6.56 feet). (Table 4 of Guide to Using this Report).

Table 4. Descriptive Terms for Common Sea Level Rise Scenarios Used in NCA5

Future global mean sea level rise and sea level rise along United States coastline are shown for five scenarios in feet (and meters), relative to a 2000 baseline. The US values shown in the right half of the table are averaged across the US coastal regions, including the contiguous US, Alaska, Hawaii and the US-Affiliated Pacific Islands, and the US Caribbean. The national values shown in the table differ substantially from regional values. For example, sea level rise is higher in the Gulf Coast and lower or even negative in some parts of Alaska. In the next 10 years (2020–2030), sea level along the contiguous US coasts is expected to rise 0.92 feet (0.28 m), the same amount of sea level rise observed over the last 100 years (1920–2020). See Chapter 9 for regional sea level information. Adapted from Sweet et al. 2022.¹

Sea Level Rise Scenario Descriptor	Global Mean Sea Level			United States		
	2050	2100	2150	2050	2100	2150
Low	0.49 (0.15)	0.98 (0.3)	1.31 (0.4)	0.59 (0.18)	0.98 (0.3)	1.64 (0.5)
Intermediate-Low	0.66 (0.20)	1.64 (0.5)	2.62 (0.8)	0.75 (0.23)	1.64 (0.5)	2.95 (0.9)
Intermediate	0.92 (0.28)	3.28 (1.0)	6.23 (1.9)	0.89 (0.27)	3.28 (1.0)	6.89 (2.1)
Intermediate-High	1.21 (0.37)	4.92 (1.5)	8.86 (2.7)	1.12 (0.34)	4.92 (1.5)	8.86 (2.7)
High	1.41 (0.43)	6.56 (2.0)	12.14 (3.7)	1.38 (0.42)	6.56 (2.0)	12.46 (3.8)

Considering only projections representing processes in whose quantification there is at least medium confidence, the IPCC AR6 assessed global mean sea level projections for 2100 to fall between 0.2 and 1.6 m (5th—95th percentile range). Nevertheless, the range of sea level rise scenarios considered by the NCA5 extends to 2.0 m. Further, the NCA5 neglects to include plausible lower scenarios, such as 0.2 m cited by the IPCC, which also corresponds to the average rate of sea level rise over the past century.

With regards to actual predictions of sea level rise, Chapter 9 of the NCA states: “Under a range of potential global warming levels, average sea level along US coastlines is *likely* to be between 12 and 20 inches above 2000 sea levels in 2050.” These values of sea level rise encompass the Intermediate scenario to values slightly higher than the High scenario from Table 4.

Global sea level rise projections to 2050 relative to a 2000 baseline can be evaluated with respect to the observed global sea level rise from 2000-2024, which is approximately 3.39 inches (0.28 feet). <https://www.climate.gov/news-features/understanding-climate/climate-change-global-sea-level> Hence NCA5 is projecting values of sea level rise between 2025 and 2050 that are 3.5 to 5.8 times the rate observed during 2000-2024.

Chapter 9 further states: “Looking toward the future, an 11 inch (28 cm) average rise along the contiguous US coastline is expected by 2050 (relative to 2020), with a *likely* range of 9-13 inches.” With regards to confidence levels, NCA5 Chapter 9 Traceable Accounts states: “There is *high confidence* and it is *likely* that sea levels will rise about 11 inches (likely range of about 9–13 inches) between 2020 and 2050”

In summary, the NCA5 presents future sea level rise scenarios that are not directly relatable either to SSP/RCP emissions scenarios or Global Warming Levels. The NCA5 scenarios include some that are higher than the 95th percentile for the extreme emissions scenario RCP8.5 that include hypothesized ice sheet processes for which there is low confidence. Projections to 2050 require rates of sea level rise from 2025 to 2050 that are more than three times the rate observed during 2020-2024. Further, the NCA5 ascribes *high confidence* to these sea level rise projections.

In summary, the NCA5 inclusion, and even the focus, on implausible extreme emissions scenarios supports projections of alarming impacts that are very unlikely to be driven by anthropogenic warming.

7 BIASED SELECTION OF REFERENCES

THIS IS WHERE THE RP JR example should go.

8 SUMMARY: EVALUATION OF THE NCA5

8.1 Inadequate NASEM Review

The NASEM Review failed to raise the issues we have discussed herein. Much of it focused on social and policy issues (e.g., Comments on Equity and Justice), rather than on the underlying science. In our assessment NASEM failed to apply the serious rigor one would expect. A few extracted comments from it will illustrate. Note that NASEM review comments are included here in blue font for reference. NASEM praised Chapter 2, saying:

The chapter [2] meets the requirements of Section 106 of the GCRA.

Yet contrary to the requirements of Section 106 the NCA5 did not discuss natural variability let alone assess the full climate record available for quantifying natural variability. Chapter 2 actually minimizes natural variability by claiming (unsubstantiated) skill in attributing recent extremes to human causes. For example NCA5's Chapter 2 Introduction states,

"...recent advances in attribution science (KM 3.3) mean that the role of climate change in some extreme events can now be quantified in real time. For example, climate change made the record-breaking Pacific Northwest heatwave of June 2021 2° to 4°F hotter, and in 2017 ..."

CWG25 reviews the expert literature demonstrating that this particular event would have happened with or without climate change and that for the CONUS, hot extremes are no more frequent now than they were in the past. NASEM did not challenge the unsubstantiated attribution claims in the NCA5.

Notwithstanding NASEM's claim that the Chapter complies with Section 106 of the GCRA it then acknowledged the absence of discussion of natural variability:

...the discussion and references regarding the role of natural climate variability and its regional differences are missing.

While a nod to natural variability is occasionally found in NCA5, it is usually followed by a "however" to emphasize human influence. One example is the statement just before the claim mentioned above pertaining to extreme event attribution: "There has always been extreme weather, which occurs even in an unchanged climate due to the natural variability of the Earth system. However, recent advances in attribution science (KM 3.3) mean that the role of climate change in some extreme events can now be quantified in real time..."

We pointed out that the evidence regarding heatwaves directly contradicts Key Message 2.2. NASEM did not mention this, instead it focused on a somewhat esoteric issue of terminology:

"Extreme Events Are Becoming More Frequent and Severe."

Key Message 2.2 is another generally well written key message. However, while the title of this key message includes the word "risk," the key message is exclusively about hazard. The Committee suggests rewriting the key message title to more accurately reflect the discussion on hazards.

The NASEM review appears to accept the NCA5's use of short data records because it makes no critical remarks about the failure to assess long time series, except for its observation that the use of short records makes the omission of natural variability that much more of a problem:

It is also important to point out that the influence of natural climate variability becomes particularly strong when the climate trend is computed based on short periods of time or small geographic areas.

This comment was largely ignored in the NCA5 final text.

8.2 Pertinent aspects when evaluating NCA5 in light of statutory requirements

- not our remit to make a ruling but here are aspects to consider in light of statutory requirements

8.3 Evaluation from the perspective of expert users of the report

- we have deep knowledge of the topics surveyed by the NCA5 authors
- we do not have confidence that the report was balanced and comprehensive
- we can point to many specific instances in which the report did not exhibit an appropriate level of quality or integrity as a scientific document
- we have reason to believe the whole process, from author selection to handling of expert reviews, was biased towards reinforcing foregone conclusions and alarmist messaging

8.4 Evaluation from the perspective of citizens interested in good policymaking

- Public concerns about climate change are valid, as are concerns about cost of living, economic growth, employment, etc.
- We share the general concern that elected officials and those who serve them have the best information available when making important decisions around energy and climate policy
- NCA5 was a missed opportunity: it could have been a valuable input to that process but it did not turn out that way
- consequently its usage is unlikely to lead to better decisions and would more likely increase the error rate in policy formation and we recommend it not be used for policymaking purposes.

APPENDIXES

APPENDIX 1: Seth's letter on statutory requirements for NCA5

APPENDIX 2: Analysis of 141 U.S. Longterm Daily Precipitation Records.

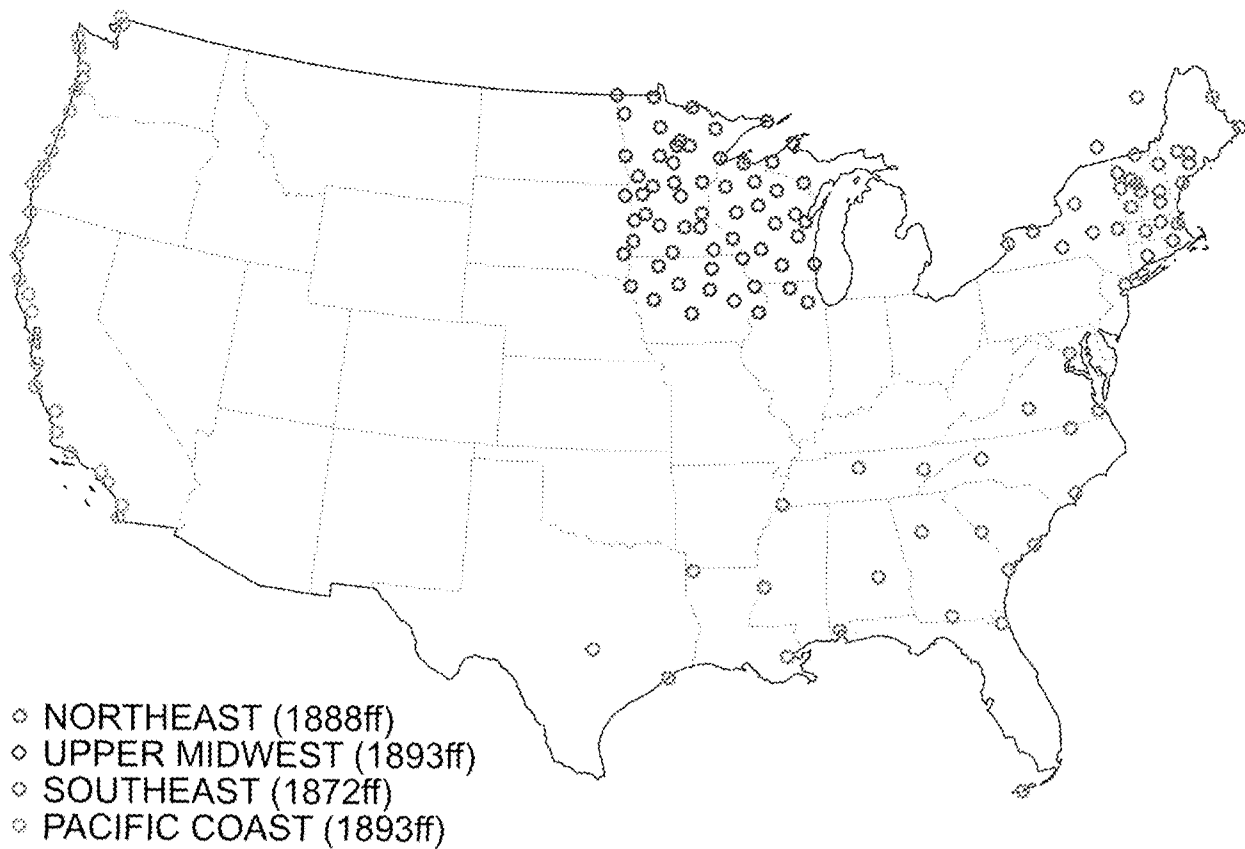


Figure. Stations used in the following analyses.

Table codes: (-) neg insignificant, -- neg significant, (+) pos insignificant, ++ pos significant.

Column 1: Measure

Column 2: Number of stations in that region

Column 3: Count of stations exhibiting a significant positive trend

Column 3: Count of stations exhibiting a significant negative trend

Column 5: Characteristic of region-wide trend

PACIFIC COAST

Since 1893:

	No. stns	+ trends	- trends	region
1-day average	29	0	1	(-)
2-day average	29	0	1	(-)
Avg on non-zero days	29	0	9	--
Variability	29	1	0	(+)
Annual max	29	2	1	(+)

Number of 99 th pct exceedances	29	1	0	(-)
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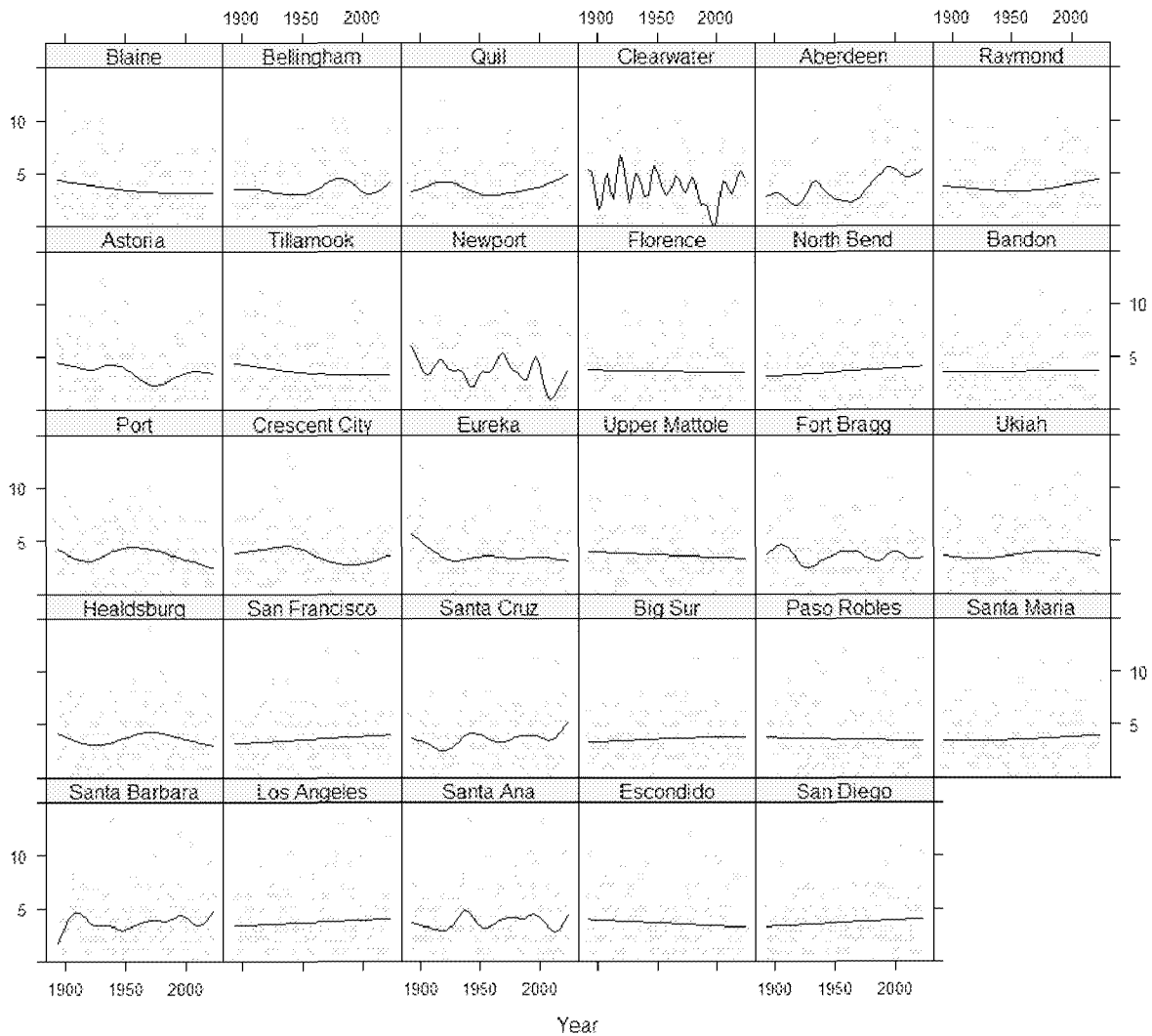
Since 1950:

	No. stns	+ trends	- trends	region
1-day average	29	0	1	(-)
2-day average	29	0	1	(-)
Avg on non-zero days	29	0	4	(-)
Variability	29	2	3	(-)
Annual max	29	6	3	(-)
Number of 99 th pct exceedances	29	2	1	(-)

Since 1980:

	No. stns	+ trends	- trends	region
1-day average	29	0	0	(-)
2-day average	29	0	0	(-)
Avg on non-zero days	29	0	1	(-)
Variability	29	0	0	(-)
Annual max	29	2	1	(-)
Number of 99 th pct exceedances	29	0	0	(+)

Annual No. 99th Percentile Exceedances PC 1893-2024



SOUTHEAST

Since 1873:

	No. stns	+ trends	- trends	region
1-day average	24	1	1	(+)
2-day average	24	1	1	(+)
Avg on non-zero days	24	7	2	(+)
Variability	24	1	0	(+)
Annual max	24	2	0	(+)
Number of 99 th pct exceedances	24	5	0	(+)

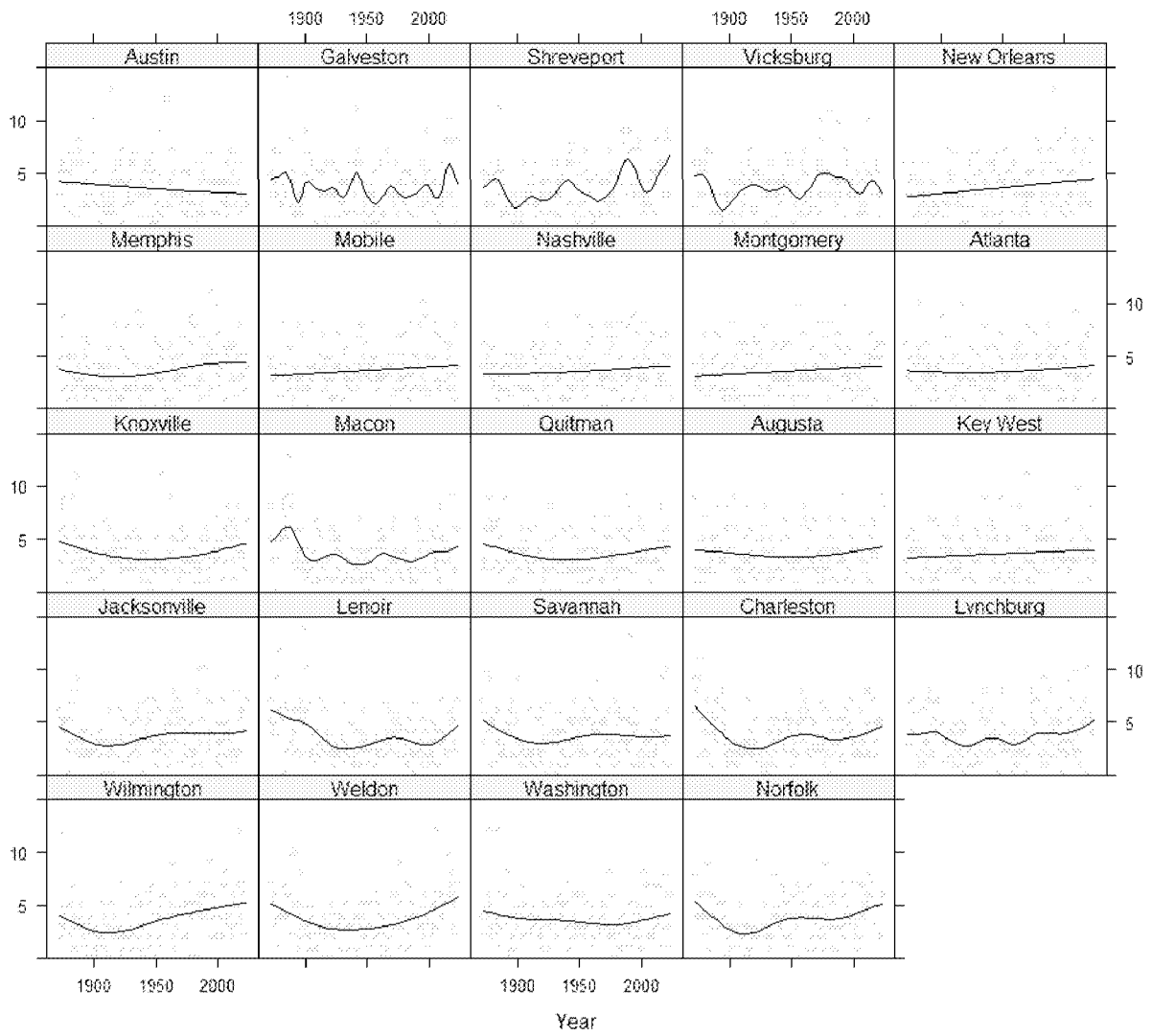
Since 1950:

	No. stns	+ trends	- trends	region
1-day average	24	5	0	++
2-day average	24	5	0	++
Avg on non-zero days	24	5	1	++
Variability	24	6	0	++
Annual max	24	4	0	++
Number of 99 th pct exceedances	24	4	0	(+)

Since 1980:

	No. stns	+ trends	- trends	region
1-day average	24	5	0	(+)
2-day average	24	5	0	(+)
Avg on non-zero days	24	5	1	(+)
Variability	24	3	0	(+)
Annual max	24	4	0	(+)
Number of 99 th pct exceedances	24	4	0	(+)

Annual No. 99th Percentile Exceedances SE 1873-2024



MIDWEST

Since 1893:

	No. stns	+ trends	- trends	region
1-day average	61	23	0	++
2-day average	61	23	0	++
Avg on non-zero days	61	2	12	(+)
Variability	61	12	0	++
Annual max	61	9	0	(+)
Number of 99 th pct exceedances	61	10	0	(+)

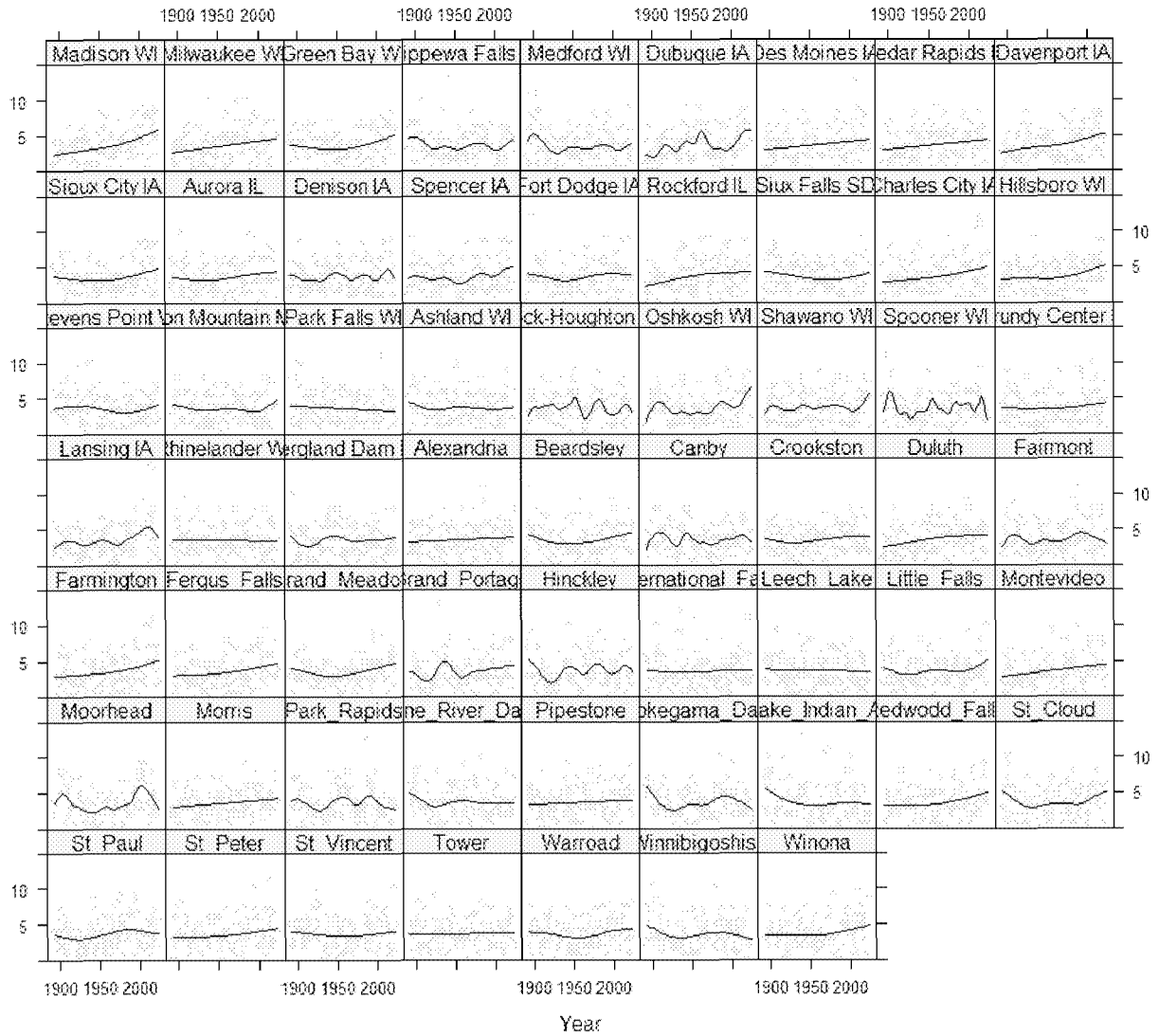
Since 1950:

	No. stns	+ trends	- trends	region
1-day average	61	28	2	++
2-day average	61	28	2	++
Avg on non-zero days	61	11	1	++
Variability	61	16	0	(+)
Annual max	61	8	0	(+)
Number of 99 th pct exceedances	61	19	0	++

Since 1980:

	No. stns	+ trends	- trends	region
1-day average	61	6	1	(+)
2-day average	61	6	1	(+)
Avg on non-zero days	61	8	2	(+)
Variability	61	5	1	(+)
Annual max	61	0	1	(+)
Number of 99 th pct exceedances	61	5	3	(-)

Annual No. 99th Percentile Exceedances MW 1893-2024



NORTHEAST

Since 1888:

	No. stns	+ trends	- trends	region
1-day average	27	12	0	++
2-day average	27	12	0	++
Avg on non-zero days	27	7	1	(+)
Variability	27	4	0	(+)
Annual max	27	3	0	(-)
Number of 99 th pct exceedances	27	5	0	(+)

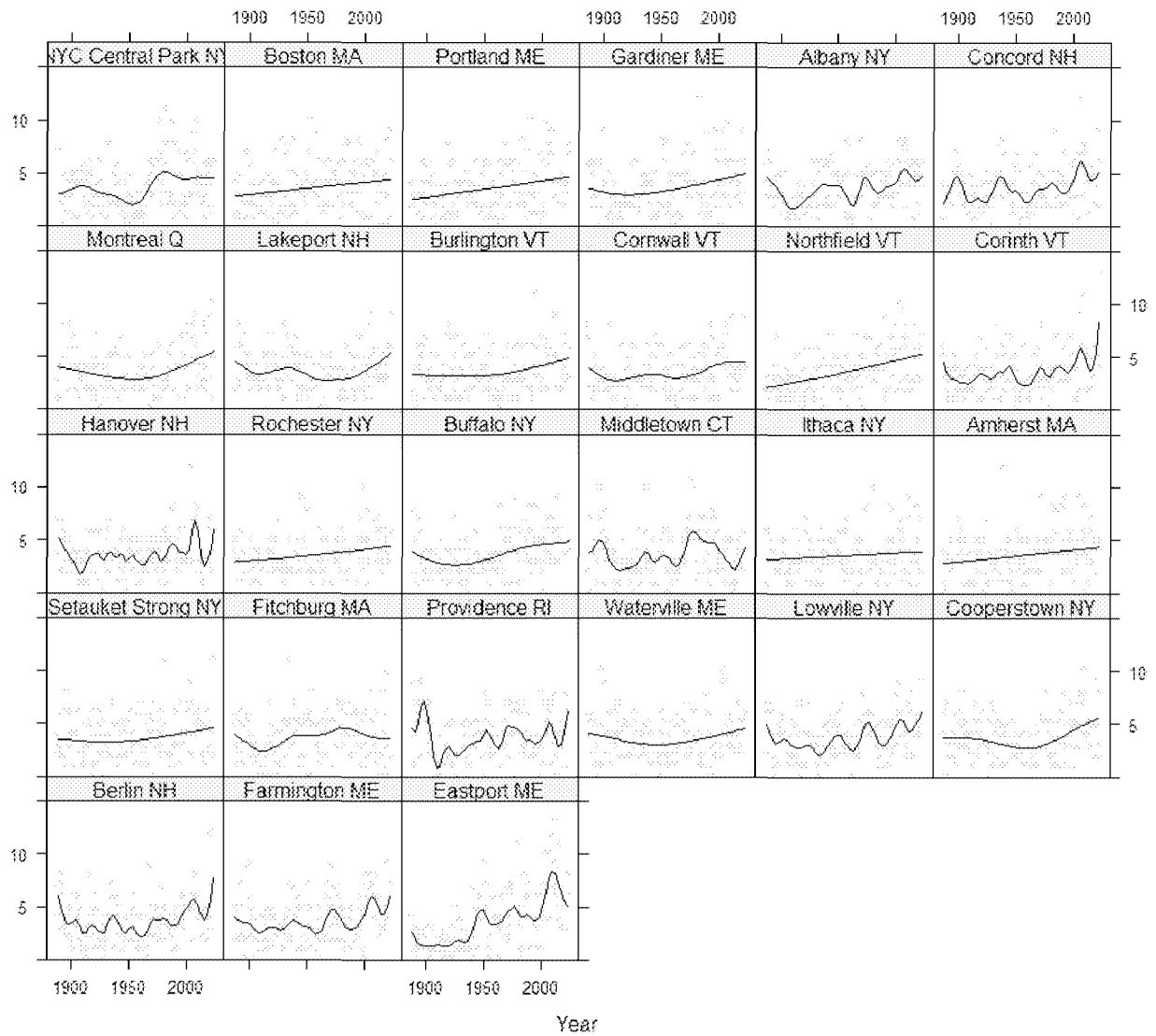
Since 1950:

	No. stns	+ trends	- trends	region
1-day average	27	12	0	++
2-day average	27	12	0	++
Avg on non-zero days	27	7	1	(+)
Variability	27	4	0	(+)
Annual max	27	3	0	(-)
Number of 99 th pct exceedances	27	5	0	++

Since 1980:

	No. stns	+ trends	- trends	region
1-day average	27	10	1	++
2-day average	27	10	1	++
Avg on non-zero days	27	6	0	(+)
Variability	27	2	0	(+)
Annual max	27	1	0	(+)
Number of 99 th pct exceedances	27	1	1	++

Annual No. 99th Percentile Exceedances NE 1888-2024



From: Judith Curry <curry.judith@gmail.com>
Sent: Wednesday, June 11, 2025 1:50 PM
To: Ross McKittrick
Cc: Roy W. Spencer; John Christy; Travis Fisher; Steven Koonin; Josh Loucks; seth.cohen@hq.doe.gov
Subject: Re: June 10 draft
Attachments: NCA5.Review.[RM].June10 Curry.docx

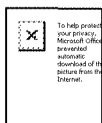
My markup is attached. Thanks to Ross for pulling this together. Much good material in the early part of the doc.

I have some substantive comments particularly regarding Chapter 3 - I suggest deleting 3.2-3.5 (for reasons discussed in the doc). Basically I think we need to make the strongest points and illustrate with the most egregious, easily understood examples (this doesn't need to be a lengthy or exhaustive doc). We shouldn't focus on explaining what the science really says, but rather the errors of judgment and procedural problems with the NCA, resulting in unjustified conclusions that make it unsuitable (and they should use the CWG report instead). My thoughts, anyways

On Tue, Jun 10, 2025 at 6:29 PM Ross McKittrick <ross.mckittrick@gmail.com> wrote:

This incorporates all the material (I think) circulated by Judy and Steve today, along with some of my edits. It's also following a suggested organization and Table of Contents, but others may have suggestions for a better flow. .

--



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Review of the Fifth National Climate Assessment

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1 INTRODUCTION

1.1 About this Report

This report responds to a request from OSTP Director Michael Kratsios (reproduced in Appendix XX) that we assess the suitability of the Fifth National Climate Assessment for informing climate and energy policies.

To conduct this assessment we reviewed NCA5 itself, NASEM review of the Third Order Draft and the USGCRP responses to the review. We have drawn upon our long experience working on advisory reports, including for the NASEM, IPCC and other organizations, as writers, reviewers and project leaders.

Our report begins with background on the National Climate Assessments. We then discuss the standards by which we have assessed NCA5, followed by specific deficiencies that we have identified

We find that NCA5 should not be relied on for policy making as it is an incomplete and misleading picture of our understanding of the changing climate and the risks it poses to the nation. NCA5 was selective and incomplete in its survey of the science as of its publication date in 2023 and has become even more so in the years since. We have reviewed many key scientific developments in a separate report to Energy Secretary Wright (Climate Working Group 2025, herein denoted “CWG25”). The overall effect of the biases and omissions of NCA5 is an excessively dire picture of climate risk.

~~Our report begins with background on the National Climate Assessments. We then discuss the standards by which we have assessed NCA5, followed by specific deficiencies that we have identified.~~

1.2 About the National Climate Assessments

The U.S. Global Change Research Program (USGCRP) was established by Presidential Initiative in 1989 and mandated by Congress in the Global Change Research Act (GCRA) of 1990 to develop and coordinate “a comprehensive and integrated United States research program which will assist the Nation and the world to understand, assess, predict, and respond to human-induced and natural processes of global change.”

The National Climate Assessment (NCA) Reports evolved from the GCRA requirement to

Prepare and submit to the President and the Congress an assessment which (1) integrates, evaluates, and interprets the findings of the Program and discusses the scientific uncertainties associated with such findings; (2) analyzes the effects of global change on the natural environment, agriculture, energy production and use, land and water resources, transportation, human health and welfare, human social systems, and biological diversity; and (3) analyzes current trends in global change, both human-induced and natural, and projects major trends for the subsequent 25 to 100 years.

The five NCA Reports to date have interpreted this mandate in different ways:

- NCA1 (2000) was a multidisciplinary effort to study and portray in regional detail the potential effects of human-induced global warming on the United States.
- NCA2 (2009) was a relatively short report that not only focused on the potential consequences of climate change, but also sought to identify potential adaptation measures and identify the highest priorities for future research.

- NCA3 (2014) was an expanded effort that continued along the lines of NCA2, and was distinguished by a comprehensive review process, including a review by the National Academy of Sciences. NCA3 introduced a traceability analysis for each key finding, including a description of uncertainties.
- NCA4 (2017/2018) was an expanded effort published in two volumes: I Climate Science Special Report, and II Impacts, Risk, and Adaptation in the United States. This was the first NCA report to devote significant effort to assessing climate science. ~~NCA4 introduced a traceability analysis for each key finding, including a cursory description of uncertainties.~~
- NCA5 (2023) returned to a single volume format, reducing discussion of climate science to a cursory two chapters, with continuing with a focus on regional and sectoral impacts of climate change. NCA5 expanded its remit to topics that are arguably outside the purview of the USGCRP, focusing on “Climate Action” and policy recommendations with a social justice emphasis. NCA5’s self-description is reproduced as Appendix II.

These successive interpretations of the NCA are poorly aligned with the GCRA’s statutory requirements. Only NCA4 gives serious consideration to climate science, which receives the great majority of USGCRP funding, and even then misrepresents some important points (~~see the Box nearby for an example~~). Natural climate variability is essentially dismissed as unimportant in NCA4 and barely mentioned in NCA5 in most contexts, despite the mandate to include both human-caused and natural climate change. Most significantly, NCA5 has redirected the focus away from climate science and even the hazard elements of impacts, towards evaluation of societal vulnerabilities and advocacy for particular policy options, especially wind and solar power. The cover image for the NCA5 Report is the installation of a solar panel.

1.3 Standards for Assessing NCA Products

In Appendix XX we include a letter of guidance from the Office of General Counsel, U.S. Department of Energy, summarizing the extent of statutory requirements governing USGCRP work products in general and NCA products in particular.

We can summarize the standards applicable to the NCA as follows:
- details.

Beyond the statutory requirements we draw attention to two other pertinent standards. President Trump’s executive order of May 23, 2025, “Restoring Gold Standard Science” enumerates some of the characteristics of good science:

- i. reproducible;
- ii. transparent;
- iii. communicative of error and uncertainty;
- iv. collaborative and interdisciplinary;
- v. skeptical of its findings and assumptions;
- vi. structured for falsifiability of hypotheses;
- vii. subject to unbiased peer review;
- viii. accepting of negative results as positive outcomes; and
- ix. without conflicts of interest.

Although these should be self-evident to those trained in science, it is surprising that some have found them controversial.

~~We consider that w~~When scientific reports are being assembled that will be highly influential on climate policymaking there are other desiderata, including statements about the strength of climate knowledge. The IPCC's approach is based on judgment of the available evidence and agreement among experts. More sophisticated knowledge characterizations for risk management include: REFERENCE AVEN SAVE THE DETAILS FOR SUBSEQUENT SECTIONS

- The degree to which the assumptions made are reasonable/realistic based on background knowledge—~~concern about the focus on implausible emissions scenarios RCP8.5/SSP5-8.5~~
- The degree to which data/information exists and are reliable and relevant—the historical and paleo database is inadequate for a complete characterization of natural climate variability on multi-decadal to millennial time scales
- The degree to which there is disagreement among experts (including those from different environments or academic fields)—attempts to suppress disagreement and alternative perspectives among experts
- The degree to which the phenomena involved are understood and accurate models exist—~~concerns about the fidelity and utility of climate models~~
- The degree to which the knowledge has been thoroughly examined with respect to unknown knowns and—~~neglect of the unknown knowns associated with natural climate variability~~

Good climate and energy policies will balance the risks and benefits of a changing climate against the world's growing demand for reliable and affordable energy. To strike that balance, policymakers must understand at least two complex and nuanced topics: the certainties and uncertainties of climate science and the technoeconomic realities of energy systems. Experts in those subjects have a unique responsibility to communicate their understanding to non-experts clearly, completely, and without bias.

Expertise in energy systems resides largely in the private sector, where it is essential to providing the reliable and affordable energy services that are the lifeblood of society. Understanding is therefore continually refined and tested by the discipline of the marketplace. In contrast, climate science expertise is found largely in the non-profit realm of universities and government laboratories and so has a more academic character.

~~Because climate is at the core of human existence, it can~~ In recent decades, climate science has engendered passion and emotion. Indeed, some younger climate scientists have gone into the field to "save the planet." So it is not surprising that objectivity can suffer when climate scientists communicate their understanding to non-experts. Further, the field of climate science has been politicized by NetZero mandates. This lack of objectivity usurps the public's right to make informed choices and undermines their confidence in the scientific enterprise.

Philip Handler, President of the National Academy of Sciences, identified the problem in a 1980 editorial that resonates eerily four decades later:

Difficulty arises in the scientific community from confusion of the role of scientist *qua* scientist with that of scientist as citizen, confusion of the ethical code of the scientist with the obligation of the citizen, blurring the distinction between intrinsically scientific and intrinsically political questions. When scientists fail to recognize these

boundaries, their own ideological beliefs, usually unspoken, easily becloud seemingly scientific debate.

1.4 When Peer-Review Fails: An Example from NCA4

Peer-review of reports like IPCC and NCA products is not a silver bullet that guarantees quality. The peer review process for these reports differs in some important respects from traditional peer review in academic journals. First, NCA reviewers self-select on a volunteer basis whether to provide comments and what parts of the report to read, whereas in academic journals Editors recruit reviewers and assign them to specific papers. There is no guarantee that any particular section of an NCA report was reviewed by anyone, let alone by someone with a different perspective than the authors. This is a problem with NCA and IPCC reports since over the years many potential reviewers have given up making the effort, because their input has systematically been ignored. Second, and related, NCA authors have near complete authority whether to accept or reject review comments. Here, for example, is how a review comment critical of a section of the NCA5 draft was handled by the authors:

THIS IS A VERY SKIMPY EXAMPLE. The comment doesn't cite any specific statement that he is complaining about.

CITE THE STATEMENT IN NCA5 TO WHICH PIELKE COMPLAINED ABOUT. ALSO CITE HIS NEW PAPER DESCRIBING THE PROBLEMS WITH HIS CITED DATA SET

<https://journals.ametsoc.org/view/journals/apme/64/4/JAMC-D-24-0222.1.xml>

REVIEWER COMMENT

Tropical Cyclones/hurricanes have not increased (Klotzbach, P.J., Bowen, S.G., Pielke, R. and Bell, M., 2018. Continental US hurricane landfall frequency and associated damage: Observations and future risks. *Bulletin of the American Meteorological Society*, 99(7), pp.1359-1376., Pielke, R., 2021. Economic Normalisation of disaster losses 1998-2020: A literature review and assessment. *Environmental Hazards*, 20(2), pp.93-111.)

US NCA RESPONSE

Thank you for your comment.

This comment is inconsistent with the author team's thorough assessment of the science.

By contrast in academic journals the Editor mandates the author to respond and the reviewer gets to assess its adequacy. Third, Once an NCA chapter author team has been selected publication of their work is guaranteed, whereas academic journals routinely reject papers if they do not pass review.

These points are important to bear in mind because some readers might dismiss any criticism of NCA products out of hand on the grounds that they were "peer reviewed". But the test of a report is whether its contents are a valid representation of the available evidence. Here we give an example in which NCA4 gave prominence to a Figure that completely misrepresented the underlying data and which evaded peer review to do so. Further details can be found in Koonin (2024).

As we pointed out in CWG25 Section 6.3 the number of heat extremes in the U.S. peaked in the 1930s and has declined ever since. Taking Considering cold and hot extremes together the U.S. the U.S.

climate has become more moderate over time. NCA4's Part I (Climate Science Special Report, CCSR) says (prominently and with *Very High Confidence*) on Page 19 of the Executive Summary:

There have been marked changes in temperature extremes across the contiguous United States. The number of high temperature records set in the past two decades far exceeds the number of low temperature records.

and offers this figure in support:

Record Warm Daily Temperatures Are Occurring More Often

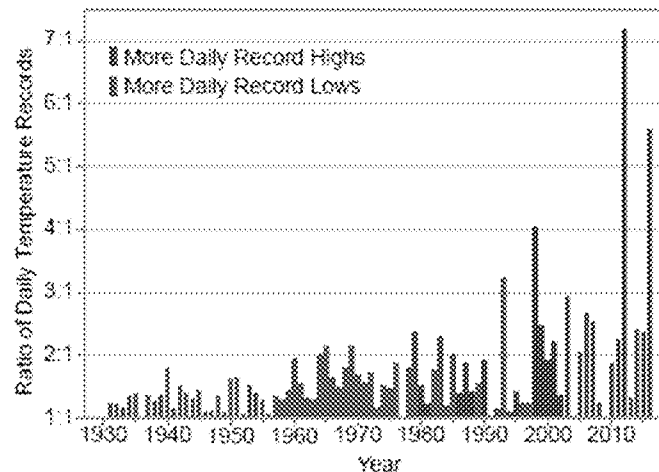
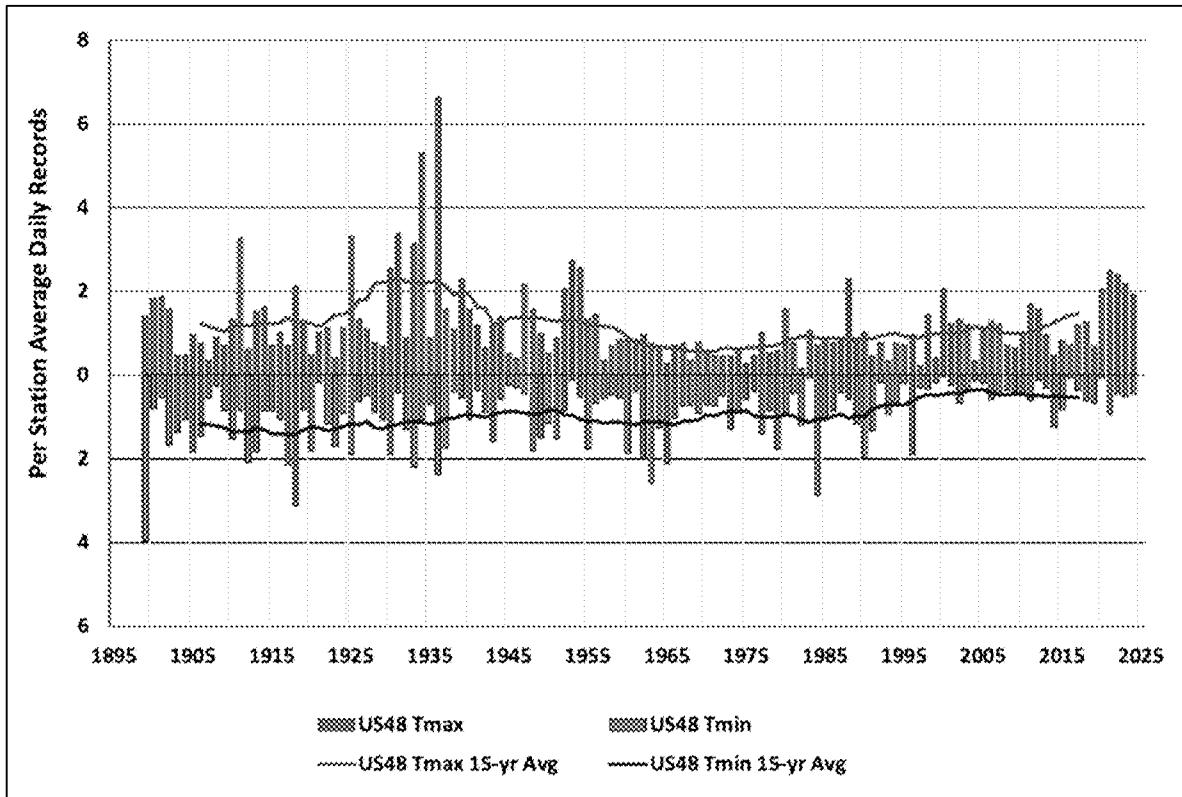


Figure ES.5: Observed changes in the occurrence of record-setting daily temperatures in the contiguous United States. Red bars indicate a year with more daily record highs than daily record lows, while blue bars indicate a year with more record lows than highs. The height of the bar indicates the ratio of record highs to lows (red) or of record lows to highs (blue). For example, a ratio of 2:1 for a blue bar means that there were twice as many record daily lows as daily record highs that year. (Figure source: NOAA/NCEI). From Figure 6.5 in Chapter 6.

The Figure appears to validate the claim that, as the title says, record warm daily temperatures are occurring more often. But the underlying data do not: they show that extreme heat in the U.S. peaked in the 1920s and 1930s and declined thereafter, as NCA4 Figure 6.4 later shows. Figure ES.5 does not show what its title implies: these are not simple counts of cold and warm extreme events; instead they are ratios of the two. In fact both types of extremes declined over the sample interval, but cold events declined more than warm events, so the ratio of warm extremes to cold extremes ~~went up~~ increased. By graphing the ratio in this way the NCA4 created a visual impression opposite to what is in the data.

Figure 6.3.3 of CWG25 (reproduced below) shows the results of a proper analysis of the data – defining each record as the singular extreme in the history, displaying numbers of warm and cold records separately, and beginning the analysis in 1899 rather than 1930. It makes evident the exceptional heat of the 1920s and especially the 1930s, peaking in 1936. The increased heat of the past five years is too brief to be deemed climatically significant and, in any event, occurred after the CCSR was published in 2017. The frequency of cold records has declined, especially over the last quarter of the period in which only 13 percent of the extreme cold events were measured. In contrast, 25 percent of the extreme Tmax records were achieved in the last quarter, which is consistent with

statistical expectations. As a result, the ratio of heat to cold extremes shown in Figure ES.5 of the CSSR explodes in recent decades. The overall reduction in numbers of both cold and hot extremes over the past century indicates a climate *less* prone to extremes, in sharp contrast to the message of the NCA4 Figure ES.5.



Number of daily record High (red) and Low (blue) temperatures for warm and cold seasons in the CONUS. The lines represent the 15-year running, centered average. Source: 1,211 USHCN stations supplemented as needed to achieve a minimum of 92 percent of observations in the 126-year period since Dec 1898. US48: contiguous U.S. states. Tmax: maximum temperature. Tmin: minimum temperature. Source: CWG25 Figure 6.3.3. **DON'T BOLD THE CAPTION**

The National Academies' expert review panel criticized the discussion of temperature extremes in a late draft of the CSSR. In reference to the CSSR's Key Finding 2 of Chapter 6, they said:

Further, it is difficult to understand how a statement that includes increases in extreme warmth can be associated with a high confidence or extremely likely statement, given that most of the graphics in this chapter show a decrease in extreme warmth in the historical record.

The Federal official in charge of the CSSR (Michael Kuperberg, Executive Director of the USGCRP) responded to the Academies' review by noting that

Almost every recommendation from the NAS was incorporated [in the final version]... and a new figure was added on changes in record high and low temperatures

The “new figure” referred to is the Figure ES.5, which did not appear in the draft reviewed by the Academies’ panel. It seems unlikely that the Academies panel ever saw that figure because they surely would have commented if they had and it wouldn’t have survived to publication. And the figure’s problems were evidently not flagged (or were ignored) in the subsequent internal government reviews.

With this background we now present our critique of NCA5.

2 NCA5 OVERVIEW CHAPTER: HYPERBOLIC ADVOCACY LANGUAGE AND NON-SCIENTIFIC TONE

The NCA5 opening Chapter 1 “Overview” holds a prominent place in the Report since it summarizes the whole report and is the only section that many will read. Although the later Chapters of NCA5 contain much sound scholarly content, Chapter 1 is marred by a pervasive tone and language that aggressively promotes emission reduction policies. ~~The authors must have known this chapter would be mined for quotes by the media and activists looking to~~ As such, this chapter adds an imprimatur of scientific authority to oversimplified declarations of opinion about public policy. ~~Many examples can be cited;~~ Here we cite a few examples that are particularly egregious.

Chapter 1 opens as follows:

The more the planet warms, the greater the impacts. Without rapid and deep reductions in global greenhouse gas emissions from human activities, the risks of accelerating sea level rise, intensifying extreme weather, and other harmful climate impacts will continue to grow. Each additional increment of warming is expected to lead to more damage and greater economic losses compared to previous increments of warming, while the risk of catastrophic or unforeseen consequences also increases.

This statement presupposes that: all warming is anthropogenic in origin, all warming is bad and causes economic damage, warming causes extreme weather to intensify. Such sweeping generalizations go well beyond what science has or can establish. A scientifically-sound version of this paragraph would instead say something like the following:

The Earth is warming because of a combination of natural and anthropogenic influences. This warming will generate a mix of benefits and harms that varies by region, to which society should be prepared to adapt. Some types of extreme weather have worsened recently, while others have not changed or have even declined in intensity. Reducing emissions of greenhouse gases might slow the warming although such policies have proven to be costly and disruptive, so any climate actions to be weighed against the potential benefits.

On the next page the Overview goes on to say:

Each additional increment of warming leads to greater risks [here it lists 7 key components of society including food security and the economy]... Without deeper cuts in global net emissions, climate risks to the US will continue to grow... Action to limit future warming and reduce risks can have near-term benefits and opportunities: low-carbon energy jobs, Improved air quality, Health benefits, Economic benefits...”

The authors write as if climate policy does not involve trade-offs and all measures to reduce future warming will be effective and beneficial. But the vast body of scholarship on climate science and economics does not support such simplistic claims. Not every additional increment of warming leads to economic harms, indeed (as is acknowledged in Chapter 19 on Economics) in some cases there will be benefits. Nor is climate policy guaranteed to create jobs or benefit the economy; in many cases it has done the opposite. Such deceit is a disservice to policymakers.

Page 9 promotes renewable energy options by noting, correctly, that the levelized costs of wind/solar generation have fallen sharply since 2010. Yet it has long been known that intermittent renewables generation must be supplemented by dispatchable generation to meet grid reliability standards, and that doing so (e.g., through natural gas, fission, or storage) ~~more than doubles the~~ can substantially increase the cost of electricity. Further, there are yet unmet synchronization challenges in transmission grids with heavy penetration of wind and solar power. ~~wind/solar-heavy grids.~~ Here again it is advisory malpractice not to acknowledge these facts.

Page 14 presents future emission scenarios with the following description: “Climate modeling experts develop global climate projections for a range of plausible futures.” The word “plausible” is applied to all the scenarios. The accompanying Figure includes both SSP3-7.0 and SSP5-8.5, the latter reaching the same radiative forcing as RCP8.5. The figure does not contrast observed emissions against previous projections nor does it caution readers that SSP3-7.0 and SSP5-8.5 are extreme worst case scenarios that, like RCP8.5, have been heavily criticized in the scientific literature (CWG25 3.2.1). By describing the entire envelope of emission projections as “plausible” the report opens the door to later presenting impacts associated with extreme and implausible emission scenarios as part of a baseline “business-as-usual” future.

~~[We could criticize Figure 1.6, which uses an anecdote to support its 1200 claim.]~~

Page 17 (and elsewhere) invokes the NOAA Billion Dollar Dataset as an indicator of extreme weather getting worse. Scientists have shown that this is an invalid metric (CWG 10.2) since it measures the growth of the economy not the frequency of extreme weather, and indeed NOAA has recently withdrawn the data product. Even though it was still distributed by NOAA at the time of the NCA5, the report authors should have assessed it skeptically and seen that it was unfit for the purpose of measuring climate trends.

Page 23 states, in large font:

Climate changes are making it harder to maintain safe homes and healthy families; reliable public services; a sustainable economy; thriving ecosystems, cultures, and traditions; and strong communities.

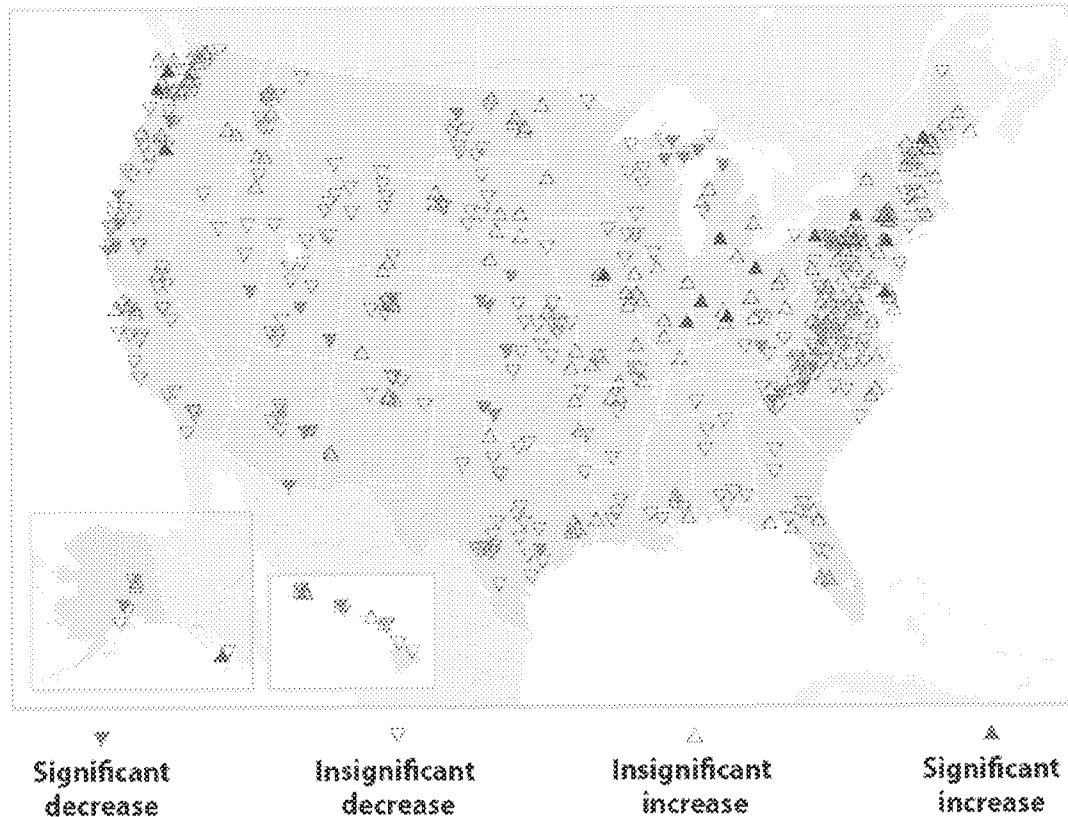
It is pointless to try to evaluate this statement on scholarly grounds; it is self-evidently hyperbolic. This kind of language doesn’t belong in a scientific assessment report. Its prominent inclusion points not only to the willingness of NCA5 authors to promote hysteria, but also the ineffectiveness of the review process at not ensuring such statements are removed.

~~DELETE THE FLOOD EXAMPLE, MUCH WEAKER THAN THE OTHERS THAT ARE FOCUSED ON POLICY AND ADVOCACY~~

~~We won’t try to cite all the remaining examples of advocacy and hyperbole in the Overview chapter; one more example will suffice. Page 26 states “Increasing flooding puts more people and assets at risk.” The accompanying figure contrasts model-projected flood losses by county in 2050 to that observed in 2020 as estimated in Wing *et al.* (2022)¹. Hence the evidence for the claim is not currently-observed trends; rather it is a model-generated projection of changes. But current trends~~

¹ Wing, Oliver, William Lehman, Paul Bates *et al.* (2022) Inequitable patterns of US flood risk in the Anthropocene. *Nature Climate Change* 12 156—162 <https://www.nature.com/articles/s41558-021-01265-6>

in U.S.-based flooding reveal a more complex picture with a general overall trend towards less flooding. The Environmental Protection Agency's "Climate Change Indicators: River Flooding" webpage² shows maps both of flood magnitude and frequency. Both show more regions experiencing declines over 1965-2015 than increases. Hence current trends indicate generally declining U.S. flood risks, but the NCA5 Overview not only fails to mention this but declares the opposite based on a single study presenting model-generated forecasts of flood activity decades in the future.



U.S. Flood magnitude trends 1965-2015.

Source: <https://www.epa.gov/climate-indicators/climate-change-indicators-river-flooding>

² <https://www.epa.gov/climate-indicators/climate-change-indicators-river-flooding>

3 OVERCONFIDENCE WHEN STATING CONCLUSIONS

3.1 Inflated certainty levels

A general pattern in the NCA5 is overconfidence in stating conclusions. The authors frequently make sweeping generalizations without appropriate caveats or acknowledging uncertainties. The overconfidence begins with inflated language to describe certainty levels.

The NCA5 uses specific terms to convey information about scientific confidence associated with important finds, observations and projections. The Front Matter of the NCA5 states that “confidence in a finding is based on the type, amount, quality, strength, and consistency of evidence; the skill, range, and consistency of methods to detect, evaluate, attribute, and interpret climate trends; and the degree of agreement across scientific information sources.”

Table 1 from the Front Matter provides calibrated language for confidence assessment:

Very high:	Strong evidence (established theory, multiple sources, well documented and accepted methods, etc.). High consensus
High:	Moderate evidence (several sources, some consistency, methods vary and/or documentation limited, etc.). Medium consensus
Medium:	Suggestive evidence (a few sources, limited consistency, methods emerging, etc.) Competing schools of thought.
Low:	Inconclusive evidence (limited sources, extrapolations, inconsistent findings, poor documentation and/or methods not tested, etc.). Disagreement or lack of opinions among experts.

This terminology is inflated: *high confidence* with just moderate evidence and medium consensus; *medium confidence* with only suggestive evidence and competing schools of thought. This inflation in terminology leads to overconfidence in the conclusions.

Even within the context of this inflated terminology, NCA5 further inflates the confidence level of many of its conclusions to well beyond what the IPCC has concluded with more thorough justification, and also by incorrectly applying its own standards. Several illustrative examples are provided.

Key Message 3.1 Traceable Account states: “There is *very high confidence* that emissions of GHGs from human activities, fossil fuel use in particular, have unequivocally caused *all* global warming observed over the industrial era.” Compare this statement with statements from the IPCC AR5 and AR6:

AR5: “It is *extremely likely* that *more than half* of the observed increase in global average surface temperature from 1951 to 2010 was caused by the anthropogenic increase in greenhouse gas concentrations and other anthropogenic forcings together.” (IPCC, 2013)

AR6: “The *likely* range of total human-caused global surface temperature increase from 1850–1900 to 2010–2019 is 0.8°C to 1.3°C, with a best estimate of 1.07°C. It is *likely* that well-mixed GHGs contributed a warming of 1.0°C to 2.0°C, other human drivers (principally aerosols)

contributed a cooling of 0.0°C to 0.8°C, natural drivers changed global surface temperature by –0.1°C to +0.1°C, and internal variability changed it by –0.2°C to +0.2°C. It is *very likely* that well-mixed GHGs were the main driver of tropospheric warming since 1979.” (IPCC, 2021)

The IPCC AR5 and AR6 statements provide likelihood assessments but not a confidence level. While the NCA5 claims with *very high confidence* that fossil fuels have unequivocally caused *all* global warming, the AR5 refers to “*more than half* of the observed warming” and the AR6 provides a more nuanced statement that relates to a *likely* range of warming contributed to by human drivers.

NCA5 Key message 2.2: “Hurricanes have been intensifying more rapidly since the 1980s (*high confidence*) and causing heavier rainfall and higher storm surges (*high confidence*).” No justification is provided in Chapter 2 for the *high confidence* conclusion on higher storm surges or hurricanes causing heavier precipitation. The Traceable Accounts section, Description of Confidence and Likelihood states: “Basic physical understanding and climate models both provide robust explanations for the links between climate change and observed changes in these extremes: this is why the authors also have *high confidence* that storms are delivering more rainfall and high confidence that storm surges are becoming higher.” In short, the NCA5 provides no observational basis or published research for their *high confidence* assertions that hurricanes are causing heavier rainfall and higher storm surges; and does not meet its own standards for a *high confidence level*.

~~I WOULD DELETE THIS EXAMPLE. FIRST, THE NCA5 PRETTY MUCH PARROTS WHAT THE AR6 SAID, AND LEWIS WAS PROBABLY PUBLISHED AFTER NCA5 LITERATURE CUTOFF. THE SENSITIVITY STUFF IS GOOD FOR THE CWG REPORT, BUT NOT FOR NCA ASSESSMENT~~

3.2—Range of climate sensitivity

Chapter 3 (Earth System Processes) states, on page 3-10, Key Message 3.2: “The Estimated Range of Climate Sensitivity Has Narrowed by 50%”. Referring to Equilibrium Climate Sensitivity (ECS) the section elaborates:

~~Recent improvements in the understanding of how climate feedbacks vary across timescales have narrowed the estimated *likely* range of warming expected from a doubling of atmospheric carbon dioxide by 50% to between 4.5°F and 7.2°F (*high confidence*).... This uncertainty reduction results from advances in combining observations and targeted modeling results from nearly independent lines of evidence, each of which generally agrees on the values of ECS. The lines of evidence include 1) observed present-day variations on monthly to interannual timescales from which cloud and other climate feedbacks are inferred; 2) observed temperature changes between the preindustrial period and present and associated relationships to ERF; and 3) estimated temperature and radiative forcing changes for multiple warm and cold periods in paleoclimate records.~~

The graphic summary on page 3-11 states

~~The reduced uncertainty in climate sensitivity and climate feedback has been achieved through unprecedented quantitative synthesis of evidence from observed changes over recent decades, the industrial era, and paleoclimate.~~

This is a grossly inadequate description of the situation. The key development in AR6 was a *reduction* of confidence in the ability of climate models to identify ECS and the shift away from the model-based

method the IPCC had relied on since AR1 in 1990. The IPCC instead turned to data-driven ECS estimation and specifically chose a single paper from the scientific literature, Sherwood *et al.* (2020³) for the purpose. It combined paleoclimate data, modern instrumental data and modern observations of climate processes, mainly cloud-related, that govern key feedbacks. Sherwood *et al.* used a subjective Bayesian method to determine the likely range of ECS values. The Bayesian approach begins with the researcher specifying a “prior”, namely an expectation of the likely distribution of answers before seeing the data. In this case the prior consists of an expected ECS range based on the researchers’ subjective beliefs. Then the data are allowed to influence the ECS distribution and the final result is a weighted average of the assumed prior and the data-driven result. Sherwood *et al.* found a best (or median) ECS estimate of 5.4°F (3°C), which was close to previous model-based estimates but raised the likely lower bound by 1.7°F from 2.5°F to 4.2°F. The IPCC accepted this result and increased the best estimate to 3.1°C.

The NCA5 was published in November 2023. Well before that, in September 2022, Lewis (2023) had been published online at *Climate Dynamics* presenting a forceful critique of Sherwood *et al.*⁴ One of Lewis’ points was that Sherwood *et al.*’s result was dependent on their chosen subjective prior. Lewis recommended using an objective Bayesian method, which places primary weight on the data rather than the researcher’s expectation. Using that and updated forcing data from AR6, Lewis estimated an ECS best estimate of 4.0°F (2.2°C) with a likely lower bound of 2.9°F (1.6°C).

Hence, in contrast to the promotional language of Chapter 3 a more valid summary of the ECS literature as it stood at the time of writing the NCA5 would be what we wrote in CWG25 (emphasis added):

For the AR6, the IPCC placed primary weight on the results of Sherwood *et al.* (2020) that combined historical and paleoclimate proxies with the process-based approach and yielded a best estimate of 3.1°C with a *likely* range of 2.6–3.9°C. Lewis (2022) raised a number of concerns about this result, including methodological errors, outdated input values, and use of subjective versus objective Bayesian priors in the analysis. Lewis’ analysis found that climate sensitivity is estimated to be much lower and better constrained than in the Sherwood *et al.* analysis—median 2.2°C (1.8–2.7°C in the 17–83 percent *likely* range, and 1.6–3.2°C in the 5–95 percent *very likely* range). **The IPCC AR6 estimated only a 5 percent probability that ECS was below 2.3°C, whereas Lewis estimated it to be over 50 percent.** The most recent publications on the debate between Sherwood *et al.* and Lewis further defend their respective positions: Sherwood and Foster (2024) and Lewis (2025).

~~I WOULD DELETE THIS EXAMPLE. WE HAVE ANOTHER MORE EFFECTIVE SECTION ON EMPHASIS ON EXTREME EMISSIONS SCENARIOS~~

3.3—New emission scenarios as a scientific “advance”

³ Sherwood, S. C., Bony, S., Boucher, O., Bretherton, C. S., Forster, P. M., Gregory, J. M., & Stevens, B. (2020). An assessment of Earth’s climate sensitivity using multiple lines of evidence. *Reviews of Geophysics*, 58(4). <https://doi.org/10.1029/2019rg000678>

⁴ Lewis, N. (2023). Objectively combining climate sensitivity evidence. *Climate Dynamics*, 61(9–10), 3155–3163. <https://doi.org/10.1007/s00382-022-06398-8>. The final citation for this paper is Lewis (2023) because the print edition did not appear until 2023, but the article was accepted in August 2022 and the online edition appeared and was in circulation in September 2022.

Chapter 3 pp. 13-14 treats the release of new emission scenarios as a scientific “advance” without addressing the failure of many previous scenarios to match reality or providing an honest assessment of the likelihood that the new ones remain biased in the same way.

Key Message 3.3 states “New Data and Analysis Methods Have Advanced Climate Science” and includes the following:

New scenarios of socioeconomic development, and their associated emissions and land-use changes, drive updated climate projections from Earth system models. The Scenario Model Intercomparison Project (ScenarioMIP) organized the main set of 21st-century projection experiments under the latest phase of the Coupled Model Intercomparison Project, CMIP6. These CMIP6 projections used newly developed scenarios based on Shared Socioeconomic Pathways (SSPs; Figure 3.4). Five SSPs represent alternative plausible trajectories of 21st-century GDP and population growth and the pace and pervasiveness of socioeconomic and technological progress within individual nations and across the world (see Table 3 in the Guide to the Report). SSP-specific drivers are used in integrated assessment models (IAMs) to simulate the corresponding evolution of the energy system and the resulting greenhouse gas trajectories. These are in turn used by ESMs to drive their 21st-century projections.

There is nothing wrong with NCA5 discussing the development of new emission scenarios which serve as inputs to climate change projections and impact studies. But it is a serious omission not to inform the reader of the failure of many previous IPCC scenarios to match reality and the tendency of the scenario groups to exaggerate near-term and long-term CO₂ concentration growth (CWG25 3.2.1). It is also a serious omission not to caution readers that many climate impact studies use RCP8.5 which by the time of NCA5 had already been heavily criticized in the literature.

The same section also reports the availability of new and larger model ensembles as a scientific advance, without addressing ways in which models are getting worse in some key respects (CWG Ch 5).

DELETE THIS SECTION. IT IS AN OBSCURE TOPIC AND DOESN'T OBVIOUSLY FIT IN THE OVERCONFIDENCE SECTION

3.4 — “Emergent Constraints” and uncertainty in climate projections

Chapter 3 page 17 presents the topic of “emergent constraints” in uncritical terms:

An approach to reduce uncertainty in climate change projections has matured over the past decade. It is known as “emergent constraints.” The term refers to strong statistical relationships between highly uncertain future climate parameters and observable trends or variations in the current climate, along with a physical explanation of this relationship.

Emergent constraints appeared in the climate modeling literature as a way to tie GCM behavior to climate observations in hopes of generating insight into real-world ECS. Climate models exhibit a wide range of sensitivities. The idea of emergent constraints is to examine whether the models with shared sensitivity values also share a common representation of some climate process (usually related to clouds) that might indirectly influence ECS. Suppose, for instance, that in low-ECS models the total cloud fraction in the tropics is strongly correlated with that in the southern midlatitudes but

in high-ECS models the correlation is weak. Then researchers could check if the observed correlation is strong or weak and draw a conclusion about which type of model, and therefore which ECS value, is more likely.

A problem in the emergent constraint literature is that there has been a large proliferation of proposed correlations with little physical motivation. Many emergent constraints patterned on CMIP5 models failed to work on CMIP6 models (Schlund *et al.* 2020)⁵. In other words, the observed correlations in CMIP5 models between ECS and cloud processes failed to show up in CMIP6 models, indicating that they were likely spurious rather than clues to physical processes governing the Earth climate system. The result was that emergent constraints estimated on CMIP5 models widened the range of estimated ECS values when applied to CMIP6 models.

Schlund *et al.* summarized the problem as follows:

In this study, we systematically analyze 11 published emergent constraints on ECS that have mostly been derived from models participating in the Coupled Model Intercomparison Project Phase 5 (CMIP5) project... The focus of the study is on testing if these emergent constraints hold for [Earth System Models] participating in the new Phase 6 (CMIP6). Since none of the emergent constraints considered here have been derived using the CMIP6 ensemble, CMIP6 can be used for cross-checking of the emergent constraints on a new model ensemble. **The application of the emergent constraints to CMIP6 data shows a decrease in skill and statistical significance of the emergent relationship for nearly all constraints, with this decrease being large in many cases.** Consequently, the size of the constrained ECS ranges (66% confidence intervals) widens by 51% on average in CMIP6 compared to CMIP5.

Yet NCA5 described the use of emergent constraint analysis as a great “advance” that reduced uncertainty.

DELETE THIS EXAMPLE, THE IMPORTANT PART OF THIS EXAMPLE IS ALREADY IN SECTION 3.1

3.5 Increasing hurricane intensity

NCA5 Key message 2.2 states

Hurricanes have been intensifying more rapidly since the 1980s (*high confidence*) and causing heavier rainfall and higher storm surges (*high confidence*).

No justification is provided in Chapter 2 for the *high confidence* conclusion on higher storm surges or hurricanes causing heavier precipitation. The Traceable Accounts section, Description of Confidence and Likelihood states:

Basic physical understanding and climate models both provide robust explanations for the links between climate change and observed changes in these extremes: this is why the authors also have *high confidence* that storms are delivering more rainfall and high confidence that storm surges are becoming higher.

⁵ Schlund, Manuel, Axel Lauer, Pierre Gentine, Steven C. Sherwood, and Veronika Eyring (2020) Emergent constraints on equilibrium climate sensitivity in CMIP5: do they hold for CMIP6? *Earth System Dynamics* 11 1233-1258 <https://doi.org/10.5194/esd-11-1233-2020>

In short, the NCA5 provides no observational basis or published research for their *high confidence* assertions that hurricanes are causing heavier rainfall and higher storm surges; and does not meet its own standards for a *high confidence level*.

3.6 Overstating findings in underlying sources

THIS ONE WORKS IN THE OVERCONFIDENCE CHAPTER, BUT THE EXAMPLES ARE NOT WELL DESCRIBED

Although we did not do a detailed audit of the NCA5's use of source material, a few spot checks turned up evidence of a pattern of overstatement.

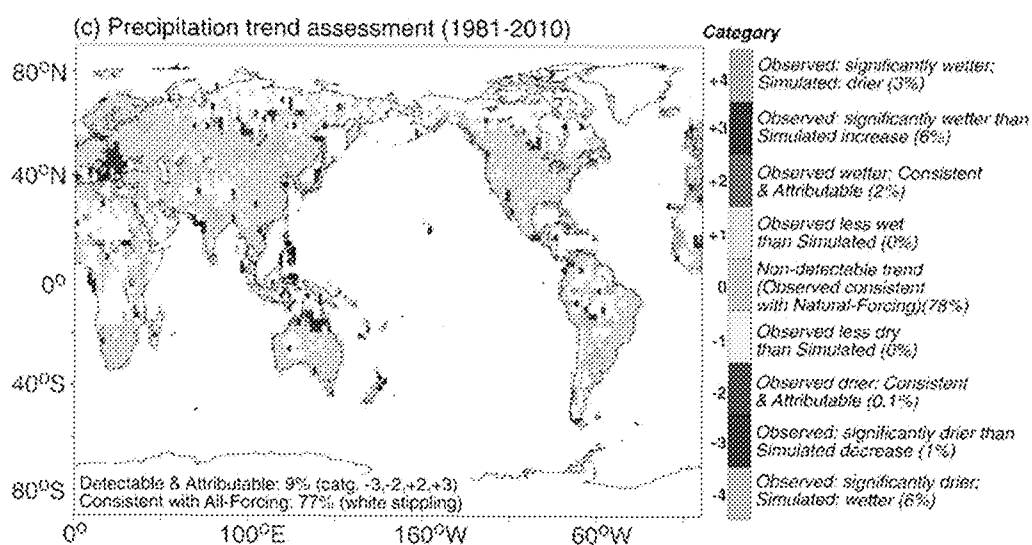
Chapter 2 page 11 reports on an increase in precipitation in central and eastern US based on a comparison of 2002-2021 average rainfall to the average over 1901-1960. Note that this a non-standard metric; we will discuss NCA5's inconsistent choices of time scales of analysis below. The change in this case is called a "trend" even though this is not how a trend is measured, and says that it is "attributable to climate change". The claims were attributed to the following paper:

WOULD BE BETTER TO PROVIDE A DIRECT QUOTE FROM THE NCA5

- Knutson, Thomas and Fanrong Zeng (2018) "Model Assessment of Observed Precipitation Trends over Land Regions: Detectable Human Influences and Possible Low Bias in Model Trends" *Journal of Climate* 31(12)
<https://journals.ametsoc.org/view/journals/clim/31/12/jcli-d-17-0672.1.xml>

But Knutson and Zeng did not say these things. It examined linear trends over 1901 – 2010, 1951 – 2010 and 1981 – 2010. It did not compare average rainfall over 2002 - 2021 to average rainfall over 1901 – 1960, indeed it was published in 2018 so it could not have. With regard to 1981-2010 trends its results were summarized in the following figure:

DON'T NEED THE FIGURE, CAN YOU PROVIDE RELEVANT QUOTE FROM KNUTSON PAPER THAT IS AT ODDS WITH NCA5 CONCLUSION



Gray indicates no trends detected. Stippling means that there were no trends in the models either so the models and observations agreed in that respect. Detectable and attributable trends were found over only 9% of the land surface of the Earth. Over the US there are detectable trends over only a few regions in the Southwest.

Consider a 2nd example. NCA5 Chapter 2 page 18 states

There is robust evidence that human-caused warming has contributed to increases in the frequency and severity of the heaviest precipitation events across nearly 70% of the US.

This is attributed to two papers:

- Diffenbaugh, N.S., D. Singh, and J.S. Mankin, 2018: Unprecedented climate events: Historical changes, aspirational targets, and national commitments. *Science Advances*, **4** (2), 3354. <https://doi.org/10.1126/sciadv.aao3354>

and

- Kirchmeier-Young, M.C. and X. Zhang, 2020: Human influence has intensified extreme precipitation in North America. *Proceedings of the National Academy of Sciences of the United States of America*, **117** (24), 13308-13313. <https://doi.org/10.1073/pnas.1921628117>

Diffenbaugh et al. presented ratios of observed occurrences of extreme events to simulated occurrence rates in CMIP6 models run with only natural forcings. They report that for 79% of the U.S. extreme rainfall event frequencies are currently higher than in model simulations, and the ratio of occurrences will rise under future warming simulations. This is not “robust” evidence of anthropogenic influence since it requires readers to assume that climate models provide accurate simulations of regional precipitation patterns, something which even the IPCC AR6 admits is uncertain (AR6 WGI SPM Box SPM 1.2, SPM Section C.1.3).

Kirchmeier-Young and Zhang looked at extreme 1- and 5-day events in North America and, using 3 GCMs, found “A signal of combined anthropogenic and natural external forcing can be detected in the intensification of extreme precipitation at the continental scale over North America. In some cases, this intensification can be attributed to human influence specifically.” However, they noted large differences among the three models in their simulated precipitation changes. Also, 2 of the 3 models failed to yield detection for Rx5Day for the North America mean. Finally, the authors used Total Least Squares, an estimation method known to overstate signal detection results (CWG Section 8.3.2). Here again this is not “robust” evidence, it is suggestive but other studies have found natural variability predominant. Both cited references utilized the implausible RCP8.5 scenario and began their “historical” observational records only in 1961.

4 RELIANCE ON *Ad Hoc* TIME SCALES FOR TREND ANALYSIS

In CWG25 Chapter 6 we discussed the need to be careful regarding the choice of time scale when making claims about trends in extreme weather. We gave examples from analysis of river flooding (6.1), heatwaves (6.3) and extreme precipitation (6.4) to show how assertions about apparent trends based on short data sets fall apart when looking at longer versions of the same data sets. Here we elaborate on these examples to illustrate a general point that NCA5 made inconsistent and *ad hoc* choices about time scales of analysis, weakening the validity of their conclusions.

McKittrick and Christy (2019)⁶ showed that apparently significant positive trends in U.S. average and extreme precipitation over the NCA4 interval (1901 – 2016) disappeared on longer samples (extending back as far as the 1840s depending on location or on a shorter interval coinciding with the final 40 years of the data then available (1978 – 2017)).

In CWG Section 6.4 we presented analysis of updated data for the same locations and many more besides, in all cases finding considerable regional heterogeneity and lack of robustness of trends to use of long samples.

4.1 Average and Extreme Precipitation

~~McKittrick and Christy (2019)⁷ showed that apparently significant positive trends in U.S. average and extreme precipitation over the NCA4 interval (1901 – 2016) disappeared on longer samples (extending back as far as the 1840s depending on location or on a shorter interval coinciding with the final 40 years of the data then available (1978 – 2017)).~~

~~In CWG Section 6.4 we presented analysis of updated data for the same locations and many more besides, in all cases finding considerable regional heterogeneity and lack of robustness of trends to use of long samples.~~

Under Key Message 2.2 “Extreme Events Are Becoming More Frequent and Severe” (p. 2-16) NCA5 states (p. 2-18):

“Rainfall is becoming more extreme”

Since the 1950s, there has been an upward trend in heavy precipitation across the contiguous US. This increase is driven largely by more frequent precipitation extremes, with relatively smaller changes in their intensity. ~~The largest increase in the number of extreme precipitation days (defined as the top 1% of heaviest precipitation events) has occurred over the Northeast (an increase of around 60%) and Midwest (around 45%), along with increases of more than 10% in their annual and 5-year maximum amount (Figure 2.8). These changes have contributed to increases in river and stream flooding in these regions. The increase in frequency and intensity of precipitation extremes is evident~~

⁶ McKittrick, R., and J.R. Christy (2019). Assessing changes in US regional precipitation on multiple time scales. *Journal of Hydrology*, 578, 124074. <https://doi.org/10.1016/j.jhydrol.2019.124074>

⁷ McKittrick, R., and J.R. Christy (2019). Assessing changes in US regional precipitation on multiple time scales. *Journal of Hydrology*, 578, 124074. <https://doi.org/10.1016/j.jhydrol.2019.124074>

across a broad range of event durations (from 1 to 30 days) and return intervals (1 to 20 years), particularly east of the Rocky Mountains.

There is robust evidence that human-caused warming has contributed to increases in the frequency and severity of the heaviest precipitation events across nearly 70% of the US. Paleoclimate records derived from tree-ring growth provide evidence that summer moisture has increased over the past century in parts of New England, the central-eastern US, and the northern Mississippi River valley.

NCA5 did not continue the NCA4 precedent of using the post-1901 interval as the time scale for its precipitation discussion, instead it refers to changes “since the 1950s” which we take to mean 1950 onwards though NCA5 Fig. 2.8 suggests 1958 as the start date. For the present report we have extended the analysis even further now to include 141 stations across the US in the Pacific Coast, Midwest, Northeast and Southeast regions. We provide details in the Appendix; here we note merely that once again it is possible to find trends that support the NCA5 position, but they are not robust to selecting longer or shorter time scales of analysis. Data from 1950 to 2024 yields many indications of increased average and extreme precipitation at individual stations and region-wide averages. But when using the entire data set (back to the 1890s or earlier depending on location) or the later subset (1980 to 2024) the trends become smaller, in many cases they become statistically insignificant, and occasionally they change sign. Only in the Northeast region are the post-1950 trends robust to focusing on the post-1980 interval.

Under Key Message 2.2 “Extreme Events Are Becoming More Frequent and Severe” (p. 2-16) NCA5 states (p. 2-18):

~~“Rainfall is becoming more extreme”~~

~~Since the 1950s, there has been an upward trend in heavy precipitation across the contiguous US. This increase is driven largely by more frequent precipitation extremes, with relatively smaller changes in their intensity.~~ The largest increase in the number of extreme precipitation days (defined as the top 1% of heaviest precipitation events) has occurred over the Northeast (an increase of around 60%) and Midwest (around 45%), along with increases of more than 10% in their annual and 5-year maximum amount (Figure 2.8). These changes have contributed to increases in river and stream flooding in these regions. The increase in frequency and intensity of precipitation extremes is evident across a broad range of event durations (from 1 to 30 days) and return intervals (1 to 20 years), particularly east of the Rocky Mountains.

There is robust evidence that human-caused warming has contributed to increases in the frequency and severity of the heaviest precipitation events across nearly 70% of the US. Paleoclimate records derived from tree-ring growth provide evidence that summer moisture has increased over the past century in parts of New England, the central-eastern US, and the northern Mississippi River valley.

The following is a more accurate summary of what U.S. data show.

There are regionally-heterogenous changes in average and extreme precipitation. Positive trends in annual average rainfall and extreme events (defined either as the annual maximum or the number of exceedances of the 99th percentile value) are generally weak or non-existent when looking at samples exceeding 130 years in length. Significant trends can be found when

beginning the sample in the 1950s although in most cases the trends weaken and become insignificant when looking at the post-1980 interval. This makes attribution to anthropogenic warming difficult.

~~Along the Pacific coast very few stations (1 or 2 out of 29) exhibit significant trends on any time scale in any metric and the region-wide trends are insignificant. In the Southeast region about 5 out of 24 stations exhibit positive trends in average and extreme precipitation metrics and the regional trends are likewise significant, but only on samples beginning in 1950. When the sample starts in 1873 or 1980 the trends weaken and become mostly insignificant. In the Midwest region nearly half the stations exhibit positive and significant trends in average precipitation since 1893 (23/61) and 1950 (28/61) but the trends weaken after 1980; only 6/61 locations are significant and the region-wide trend is insignificant. These positive trends reflect the dryness of the 1930's Dust Bowl era. Regional trends in max and 99th percentile exceedances are insignificant post-1893 and 1980 but the latter are positive and significant post-1950.~~

~~In the Northeast region 12 out of 27 stations exhibit positive and significant increases in average precipitation post-1888, post-1950 and post-1980 (10/27) and the regional trend is positive and significant in all three intervals. The regional number of 99th percentile exceedances has a positive trend post-1950 and post-1980 but not post-1888. The significant positive trends post-1980 are concentrated in NH but are insignificant elsewhere.~~

~~Consequently, precipitation in the U.S. exhibits considerable regional and temporal variability. Relatively more places became wetter than drier. In the Midwest and Northeast the general pattern since 1950 favors increased precipitation depending on the location, although trends since 1980 have not tended to be statistically significant.~~

KEEP IT FOCUSED ON THEIR MISREPRESENTATION OF EXTREME PRECIP

4.2 Heatwaves

- details; NCA4 used entire 20th century while NCA5 looked at post-1960 interval

5 INADEQUATE TRACEABLE ACCOUNTS

Starting with the NCA3, the NCA has included a section on Traceable Accounts at the end of each Chapter. A description from the NCA5:

“Each chapter concludes with a section entitled Traceable Accounts, which provides information on the overall process used to develop the chapter as well as a separate Traceable Account section for each Key Message. These Traceable Accounts describe the supporting evidence behind each Key Message, the process and rationale authors used in reaching their conclusions, and the author team’s expert assessment of the confidence in and, where applicable, likelihood of these conclusions. As such, Traceable Accounts provide information about the state of the science, document sources of uncertainty, identify research gaps, and allow traceability to data and resources.”

The Traceable Accounts for each Chapter and Key Message includes the following sections:

- Description of Evidence Base
- Major Uncertainties and Research Gaps
- Description of Confidence and Likelihood

The Traceable Accounts are in principle an important factor in addressing the NCA's statutory requirement to discuss scientific uncertainties. Further, the Traceable Accounts can help satisfy the Executive Order for Restoring Gold Standard Science with regards to: reproducibility, transparency, communication of error and uncertainty, and skepticism of findings and assumptions.

However, the execution of the Traceable Accounts is uneven, often superficial and noninformative in Chapters 2 and 3 (which were the only Chapters investigated here). An example from Chapter 2:

Key Message 2.2: Extreme Events are Becoming More Frequent and Severe.

Description of the Evidence Base consists of two paragraphs, with the first paragraph summarizing the findings and the second paragraph providing a generic description of the types of data that can be used for storms. Major Uncertainties and Research Gaps focuses on the uneven distribution across US populations due to differences in exposure and vulnerability. The only limitations in data referred to are the lack of a long-term record of lightning, and the lack of homogenized daily and hourly temperature data except from reanalysis products.

The most astonishing deficiency is in the Description of Confidence and Likelihood. One of the statements in Key Message 2.2 is: "Hurricanes have been intensifying more rapidly since the 1980s (high confidence) and causing heavier rainfall and higher storm surges (high confidence)." The Description of Confidence and Likelihood includes the following statement: "Basic physical understanding and climate models both provide robust explanations for the links between climate change and observed changes in these extremes: this is why the authors also have high confidence that storms are delivering more rainfall and high confidence that storm surges are becoming higher." No reference to journal publications or a specific data set is made in the Chapter regarding hurricane induced precipitation or storm surge to support this *high confidence* conclusion.

With regards to Chapter 3, there are some substantial inconsistencies between the Traceable Accounts for the different Key Findings:

Key Message 3-1: Human activities have caused global warming.

Confidence and Likelihood: "There is *very high confidence* that emissions of GHGs from human activities, fossil fuel use in particular, have *unequivocally* caused all global warming observed over the industrial era. There is also *very high confidence* that changes in natural climate drivers have had globally small and regionally variable long-term effects over this period." The Uncertainties section only addresses uncertainties in radiative forcing of greenhouse gases.

By contrast, consider Key Message 3-4: Humans are changing Earth System processes. The Traceability Analysis in this section contains arguably the most scientifically credible text in the entire Chapter. From Description of Evidence Base: "In the last decade, there has been increasing recognition of the role of regional-scale natural variability in the past and future evolution of climate, as well as the fact that regional natural variability signals can be competitive with forced anthropogenic signals". From Major Uncertainties and Research Gaps: "For example, the true natural variability of the climate system on decadal to

centennial timescales could be larger than what we estimate from GCMs, which would further increase the irreducible uncertainty stemming from natural variability.”

As part of the Traceable Account: “Each figure and some tables are accompanied by a metadata survey, which can be accessed in the online version of the report by clicking on the eyeball icon above the figure or table (see the table below for explanations of additional icons used throughout the report). The metadata survey describes data sources, figure or table development methods, copyright information, and other important documentation.” Upon clicking on the eyeball icon above a particular figure, a Contact US email appears, addressed to the USGCRP. No attempt was made to send a email to elicit the Metadata information, but it is clear that this information is not readily accessible online.

In summary, the Traceable Analyses examined here, with few exceptions, fail to meet the stated objectives set forward by the NCA.

6 OVEREMPHASIS ON EXTREME SCENARIOS

To respond to the GCRA mandate to “project major trends for the subsequent 25 to 100 years,” the NCA relies on projections of future climate change based on estimates of future emissions (the so-called SSP scenarios) and/or specified levels of radiative forcing (the RCP scenarios). For the most part, NCA5 uses scenarios developed for the IPCC Assessment Reports.

In CWG Section 3.2.1 we presented a critical assessment of past and current IPCC scenario envelopes, showing that they have tended to overshoot observed emissions. ~~In 2021, UN Climate Negotiators (COP) stopped using scenarios above 4.5.~~ The IPCC AR6 published in 2021 stated that “The likelihood of high-emission scenarios like RCP8.5 and SSP5-8.5 is considered low in light of recent energy sector developments.” In 2021, UN Climate Negotiators (COP) stopped using scenarios above 4.5. NCA5 makes the following observations about the scenarios they use:

“NCA5 authors were advised to assess the full range of scenarios available.” (Front Matter)

“Scenarios of future emissions and land-use change are developed as plausible alternatives, but no relative likelihood is attached to them. Some recent studies, however, have argued that the highest scenario, SSP5-8.5, is no longer plausible without a reversal of current trends in the adoption of renewables and energy efficiency.” (Key Message 3.3 Traceable Analysis)

Despite acknowledging the issue the NCA5 otherwise ignored the problem. A keyword search of the NCA5 of mentions of RCP/SSP scenarios finds over 50% referred to the extreme emissions scenarios RCP8.5/SSP5-8.5. Further, 10 figures only included the 8.5 scenarios: 5.2, 6.9, 7.4, 11.3, 14.6, 22.13, 22.19, 27.9, 29.13.

The problem of relying on extreme scenarios is particularly acute for NCA5’s sea level rise projections. The sea level rise scenarios used in the NCA5 do not relate directly to the SSP emissions scenarios, but to specified amounts of sea level rise by 2100, whereby Low relates to 0.3 m (0.98 feet), Intermediate-Low relates to 0.5 m (1.64 feet), Intermediate relates to 1.0 m (3.28 feet), Intermediate-High relates to 1.5 m (4.92 feet), and High relates to 2.0 m (6.56 feet). (Table 4 of Guide to Using this Report).

Table 4. Descriptive Terms for Common Sea Level Rise Scenarios Used in NCA5

Future global mean sea level rise and sea level rise along United States coastline are shown for five scenarios in feet (and meters), relative to a 2000 baseline. The US values shown in the right half of the table are averaged across the US coastal regions, including the contiguous US, Alaska, Hawaii and the US-Affiliated Pacific Islands, and the US Caribbean. The national values shown in the table differ substantially from regional values. For example, sea level rise is higher in the Gulf Coast and lower or even negative in some parts of Alaska. In the next 30 years (2020–2050), sea level along the contiguous US coasts is expected to rise 0.92 feet (0.28 m), the same amount of sea level rise observed over the last 100 years (1920–2020). See Chapter 9 for regional sea level information. Adapted from Sweet et al. 2022.”

Sea Level Rise Scenario Descriptor	Global Mean Sea Level			United States		
Year	2050	2100	2150	2050	2100	2150
Low	0.49 (0.15)	0.98 (0.3)	1.31 (0.4)	0.59 (0.18)	0.98 (0.3)	1.64 (0.5)
Intermediate-Low	0.66 (0.20)	1.64 (0.5)	2.62 (0.8)	0.75 (0.23)	1.64 (0.5)	2.95 (0.9)
Intermediate	0.92 (0.28)	3.28 (1.0)	6.23 (1.9)	0.89 (0.27)	3.28 (1.0)	6.89 (2.1)
Intermediate-High	1.21 (0.37)	4.92 (1.5)	8.86 (2.7)	1.12 (0.34)	4.92 (1.5)	8.86 (2.7)
High	1.41 (0.43)	6.56 (2.0)	12.14 (3.7)	1.38 (0.42)	6.56 (2.0)	12.46 (3.8)

Considering only projections representing processes in whose quantification there is at least medium confidence, the IPCC AR6 assessed global mean sea level projections for 2100 to fall between 0.2 and 1.6 m (5th—95th percentile range). Nevertheless, the range of sea level rise scenarios considered by the NCA5 is from 1.5 extends to 2.0 m. Further, the NCA5 neglects to include plausible lower scenarios, such as 0.2 m cited by the IPCC, which also corresponds to the average rate of sea level rise over the past century.

With regards to actual predictions of sea level rise, Chapter 9 of the NCA states: “Under a range of potential global warming levels, average sea level along US coastlines is *likely* to be between 12 and 20 inches above 2000 sea levels in 2050.” These values of sea level rise encompass the Intermediate scenario to values slightly higher than the High scenario from Table 4.

Global sea level rise projections to 2050 relative to a 2000 baseline can be evaluated with respect to the observed global sea level rise from 2000-2024, which is approximately 3.39 inches (0.28 feet). <https://www.climate.gov/news-features/understanding-climate/climate-change-global-sea-level> Hence it is inferred that NCA5 is projecting values of sea level rise between 2025 and 2050 that are 3.5 to 5.8 times the rate observed during 2000-2024.

Chapter 9 further states: “Looking toward the future, an 11 inch (28 cm) average rise along the contiguous US coastline is expected by 2050 (relative to 2020), with a *likely* range of 9-13 inches.” This analysis accounts for the observed sea level rise between 2000 and 2020. But they say it’s relative to 2020. With regards to confidence levels, NCA5 Chapter 9 Traceable Accounts states: “There is *high confidence* and it is *likely* that sea levels will rise about 11 inches (likely range of about 9–13 inches) between 2020 and 2050” Neither the statement nor the context in the paragraph distinguishes as to whether this refers to global sea level rise, or US average sea level rise, although it is inferred to refer to global sea level rise.

In summary, the NCA5 presents future sea level rise scenarios that are not directly relatable either to SSP/RCP emissions scenarios or Global Warming Levels. The NCA5 scenarios include two scenarios that are higher than the 95th percentile for the extreme emissions scenario RCP8.5 and that include hypothesized ice sheet processes for which there is low confidence. Projections to 2050 require rates of sea level rise from 2025 to 2050 that are more than three times the rate observed during 2020-2024. Further, the NCA5 ascribes *high confidence* to these sea level rise projections.

In summary, the NCA5 inclusion, and even the focus, on implausible extreme emissions scenarios supports projections of alarming impacts that are very unlikely to be driven by anthropogenic warming.

7 BIASED SELECTION OF REFERENCES

THIS IS WHERE THE RP JR example should go.

8 SUMMARY: EVALUATION OF THE NCA5

8.1 Pertinent aspects when evaluating in light of statutory requirements

- not our remit to make a ruling but here are aspects to consider in light of statutory requirements

8.2 Evaluation from the perspective of expert users of the report

- we have deep knowledge of the topics surveyed by the NCA5 authors
- we do not have confidence that the report was balanced and comprehensive
- we can point to many specific instances in which the report did not exhibit an appropriate level of quality or integrity as a scientific document
- we have reason to believe the whole process, from author selection to handling of expert reviews, was biased towards reinforcing foregone conclusions and alarmist messaging

8.3 Evaluation from the perspective of citizens interested in good policymaking

- Public concerns about climate change are valid, as are concerns about cost of living, economic growth, employment, etc.
- We share the general concern that elected officials and those who serve them have the best information available when making important decisions around energy and climate policy
- NCA5 was a missed opportunity: it could have been a valuable input to that process but it did not turn out that way

- consequently its usage is unlikely to lead to better decisions and would more likely increase the error rate in policy formation and we recommend it not be used for policymaking purposes.

APPENDIX 1: Seth's letter on statutory requirements for NCA5

APPENDIX 2: Analysis of 141 U.S. Longterm Daily Precipitation Records.

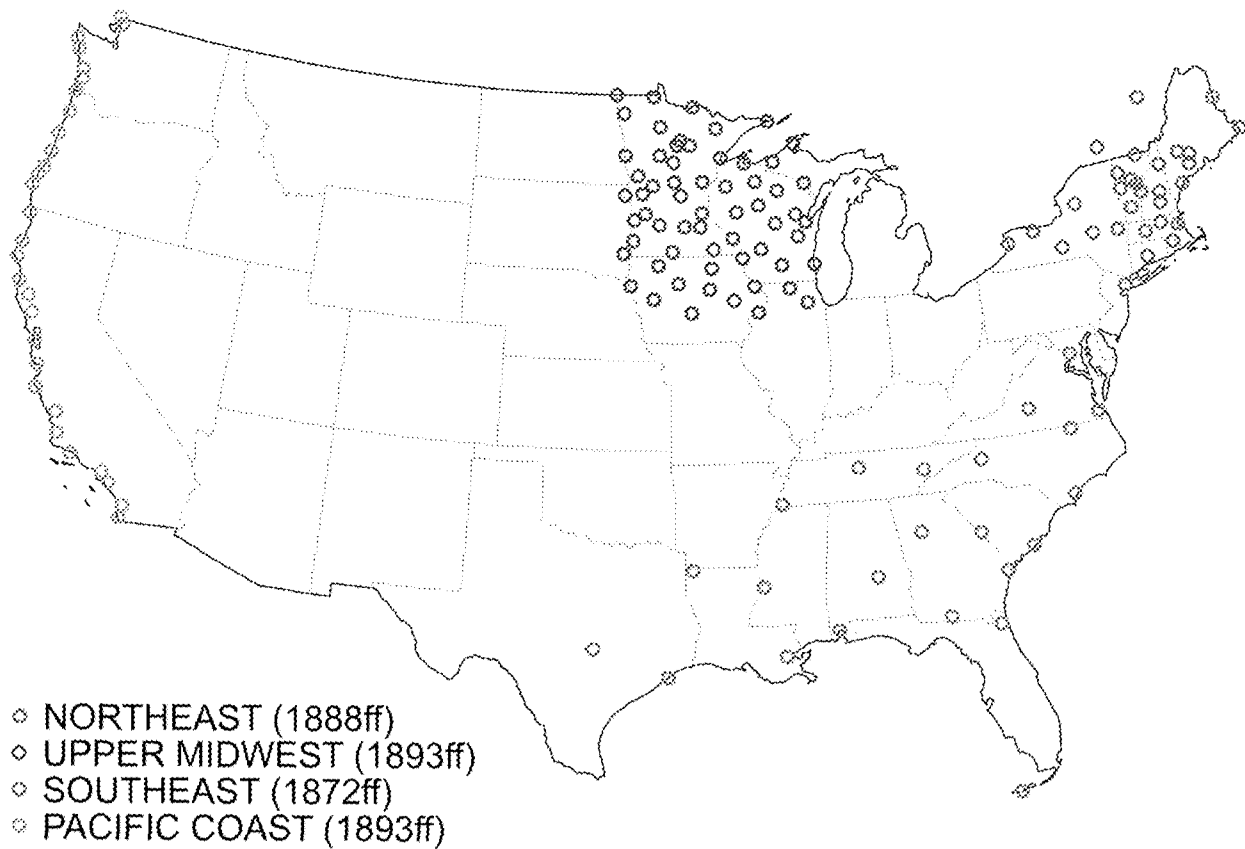


Figure. Stations used in the following analyses.

Table codes: (-) neg insignificant, -- neg significant, (+) pos insignificant, ++ pos significant.

Column 1: Measure

Column 2: Number of stations in that region

Column 3: Count of stations exhibiting a significant positive trend

Column 3: Count of stations exhibiting a significant negative trend

Column 5: Characteristic of region-wide trend

PACIFIC COAST

Since 1893:

	No. stns	+ trends	- trends	region
1-day average	29	0	1	(-)
2-day average	29	0	1	(-)
Avg on non-zero days	29	0	9	--
Variability	29	1	0	(+)
Annual max	29	2	1	(+)

Number of 99 th pct exceedances	29	1	0	(-)
--	----	---	---	-----

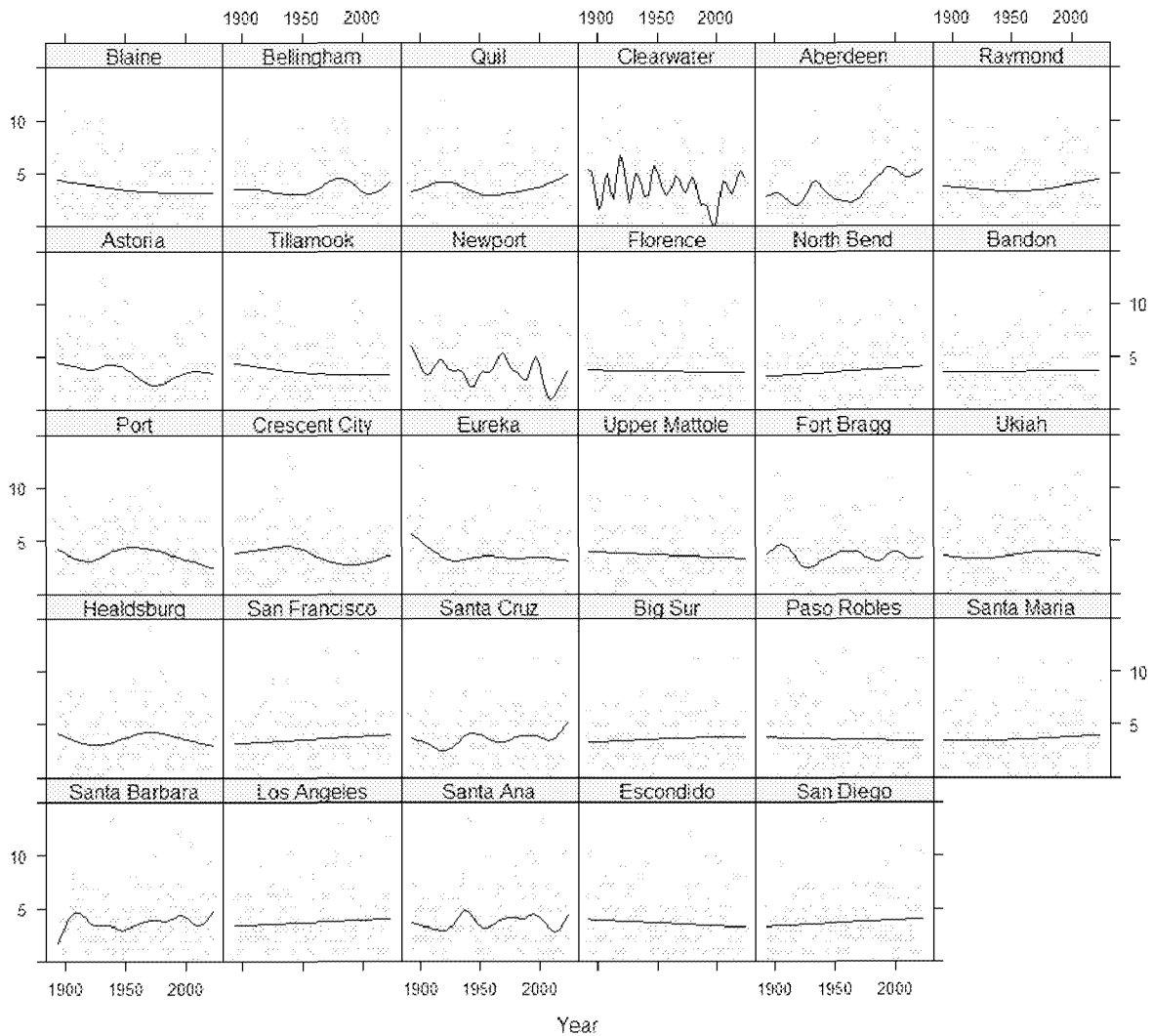
Since 1950:

	No. stns	+ trends	- trends	region
1-day average	29	0	1	(-)
2-day average	29	0	1	(-)
Avg on non-zero days	29	0	4	(-)
Variability	29	2	3	(-)
Annual max	29	6	3	(-)
Number of 99 th pct exceedances	29	2	1	(-)

Since 1980:

	No. stns	+ trends	- trends	region
1-day average	29	0	0	(-)
2-day average	29	0	0	(-)
Avg on non-zero days	29	0	1	(-)
Variability	29	0	0	(-)
Annual max	29	2	1	(-)
Number of 99 th pct exceedances	29	0	0	(+)

Annual No. 99th Percentile Exceedances PC 1893-2024



SOUTHEAST

Since 1873:

	No. stns	+ trends	- trends	region
1-day average	24	1	1	(+)
2-day average	24	1	1	(+)
Avg on non-zero days	24	7	2	(+)
Variability	24	1	0	(+)
Annual max	24	2	0	(+)
Number of 99 th pct exceedances	24	5	0	(+)

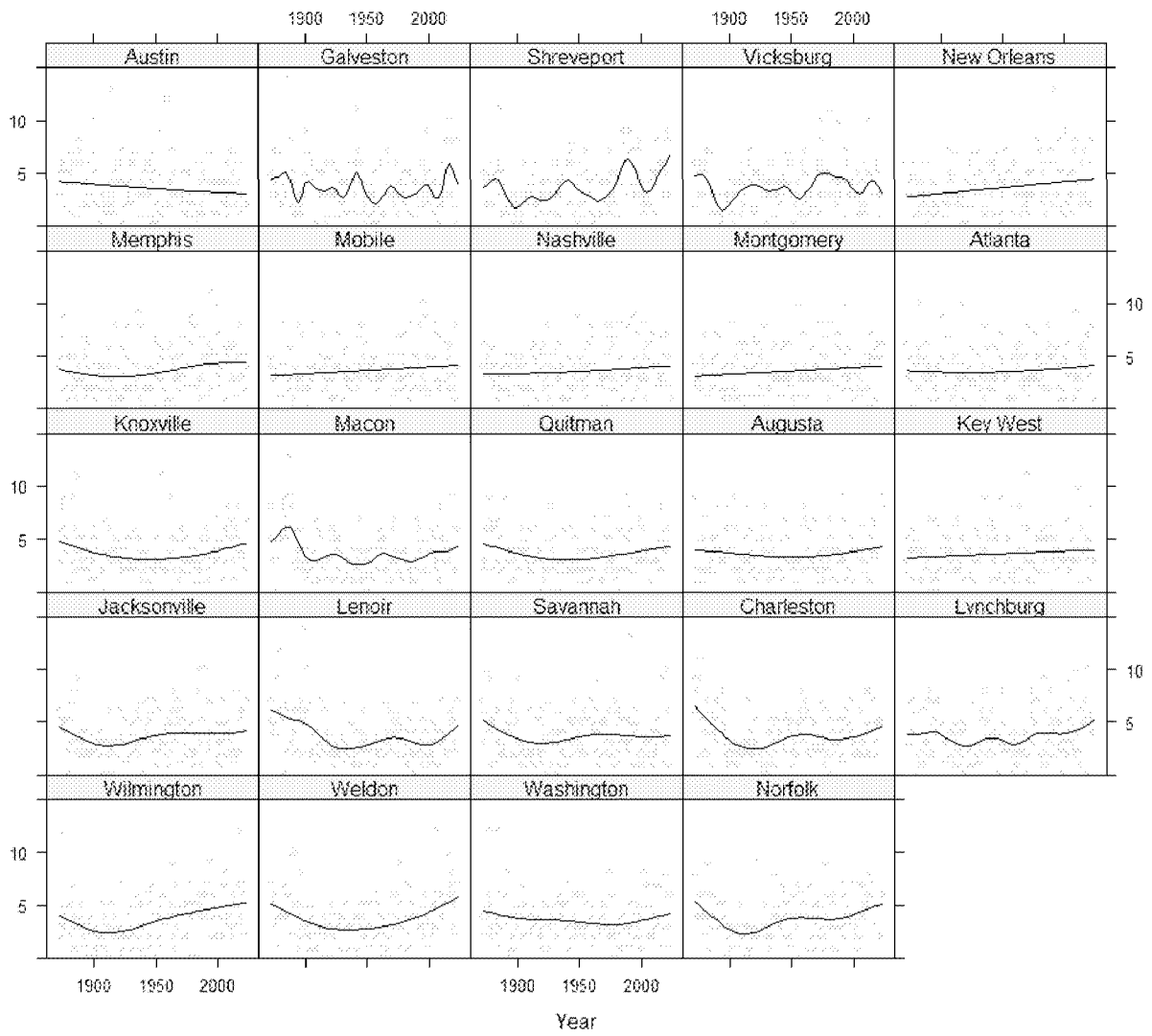
Since 1950:

	No. stns	+ trends	- trends	region
1-day average	24	5	0	++
2-day average	24	5	0	++
Avg on non-zero days	24	5	1	++
Variability	24	6	0	++
Annual max	24	4	0	++
Number of 99 th pct exceedances	24	4	0	(+)

Since 1980:

	No. stns	+ trends	- trends	region
1-day average	24	5	0	(+)
2-day average	24	5	0	(+)
Avg on non-zero days	24	5	1	(+)
Variability	24	3	0	(+)
Annual max	24	4	0	(+)
Number of 99 th pct exceedances	24	4	0	(+)

Annual No. 99th Percentile Exceedances SE 1873-2024



MIDWEST

Since 1893:

	No. stns	+ trends	- trends	region
1-day average	61	23	0	++
2-day average	61	23	0	++
Avg on non-zero days	61	2	12	(+)
Variability	61	12	0	++
Annual max	61	9	0	(+)
Number of 99 th pct exceedances	61	10	0	(+)

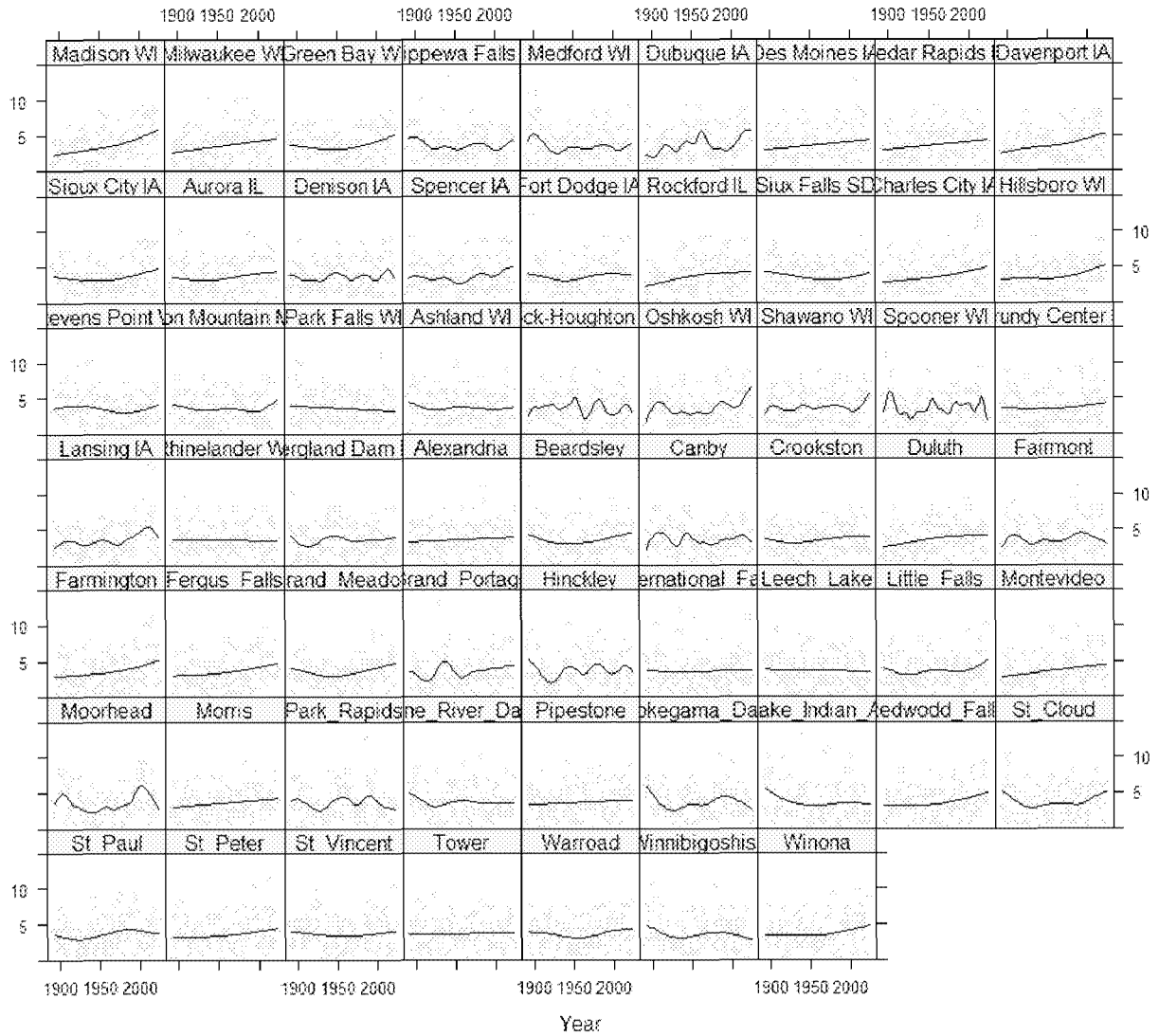
Since 1950:

	No. stns	+ trends	- trends	region
1-day average	61	28	2	++
2-day average	61	28	2	++
Avg on non-zero days	61	11	1	++
Variability	61	16	0	(+)
Annual max	61	8	0	(+)
Number of 99 th pct exceedances	61	19	0	++

Since 1980:

	No. stns	+ trends	- trends	region
1-day average	61	6	1	(+)
2-day average	61	6	1	(+)
Avg on non-zero days	61	8	2	(+)
Variability	61	5	1	(+)
Annual max	61	0	1	(+)
Number of 99 th pct exceedances	61	5	3	(-)

Annual No. 99th Percentile Exceedances MW 1893-2024



NORTHEAST

Since 1888:

	No. stns	+ trends	- trends	region
1-day average	27	12	0	++
2-day average	27	12	0	++
Avg on non-zero days	27	7	1	(+)
Variability	27	4	0	(+)
Annual max	27	3	0	(-)
Number of 99 th pct exceedances	27	5	0	(+)

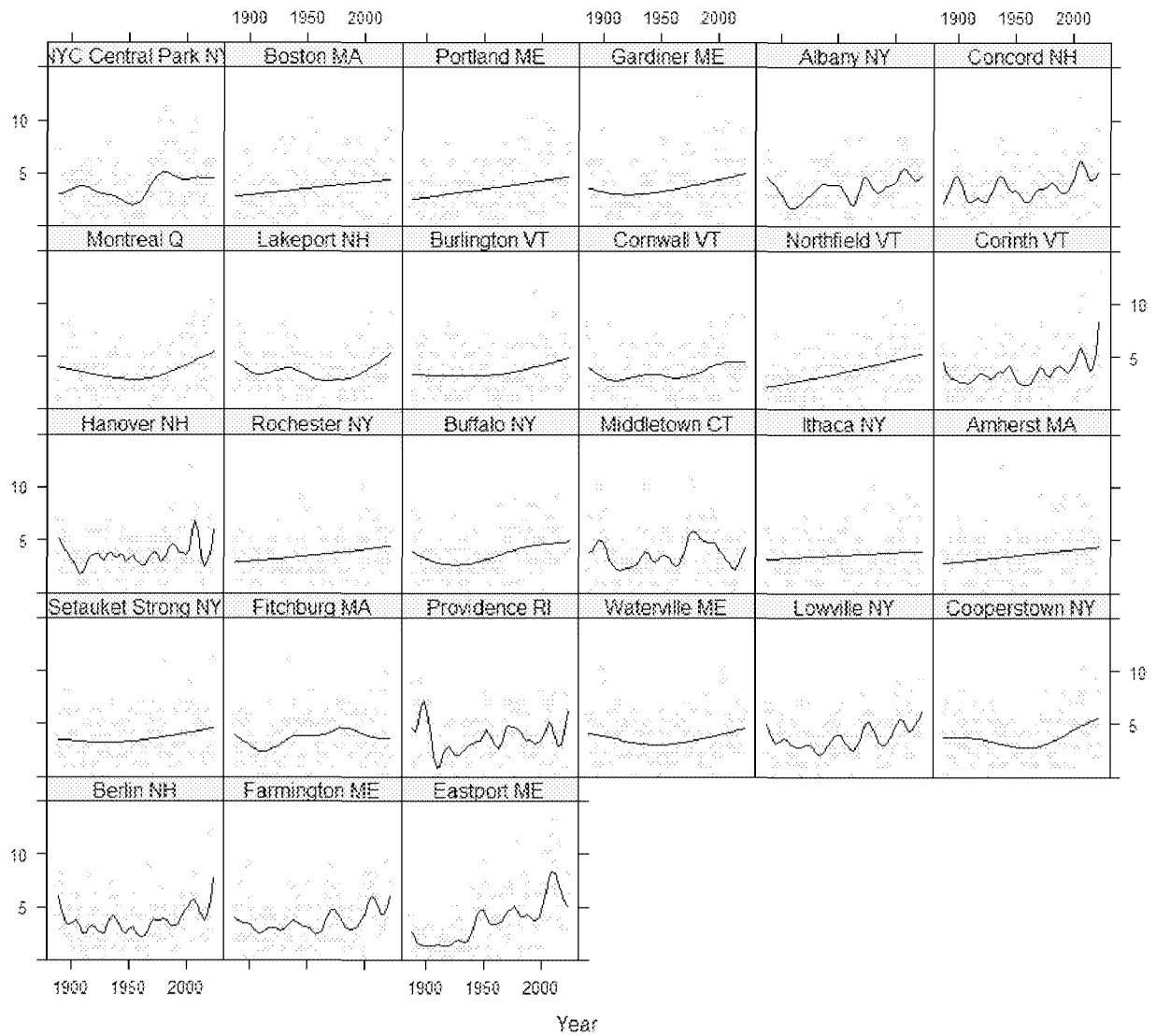
Since 1950:

	No. stns	+ trends	- trends	region
1-day average	27	12	0	++
2-day average	27	12	0	++
Avg on non-zero days	27	7	1	(+)
Variability	27	4	0	(+)
Annual max	27	3	0	(-)
Number of 99 th pct exceedances	27	5	0	++

Since 1980:

	No. stns	+ trends	- trends	region
1-day average	27	10	1	++
2-day average	27	10	1	++
Avg on non-zero days	27	6	0	(+)
Variability	27	2	0	(+)
Annual max	27	1	0	(+)
Number of 99 th pct exceedances	27	1	1	++

Annual No. 99th Percentile Exceedances NE 1888-2024



From: John Christy [climateman60@gmail.com]
Sent: 6/11/2025 3:08:56 PM
To: Ross McKittrick [ross.mckittrick@gmail.com]
CC: Judith Curry [curry.judith@gmail.com]; Roy W. Spencer [roywspencer@hotmail.com]; Travis Fisher [travis.scott.fisher@gmail.com]; Steven Koonin [steven.koonin@gmail.com]; Josh Loucks [loucksj14@gmail.com]; seth.cohen@hq.doe.gov
Subject: Re: June 10 draft
Attachments: NCA5_Sec_4.2 Heat_Ext_JRC250611.0.docx

Steve and Ross

Not sure who is keeping the Master. Here is a slightly edited version of 4.2 Heat Extremes/Heat waves

John C.

On Wed, Jun 11, 2025 at 9:54 AM John Christy <climateman60@gmail.com> wrote:
Ross

Notes on version June10.

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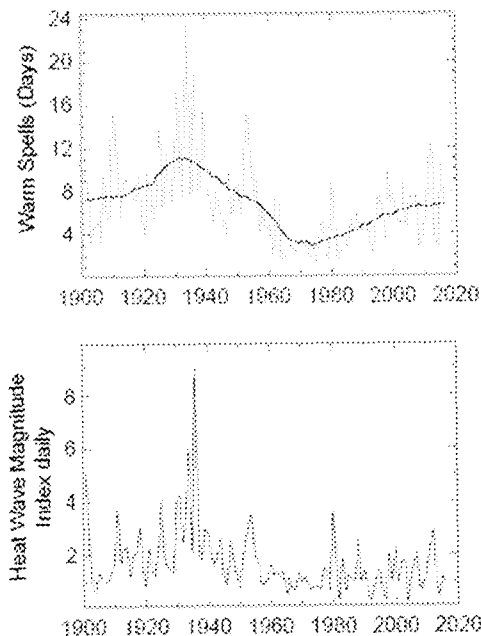
This incorporates all the material (I think) circulated by Judy and Steve today, along with some of my edits. It's also following a suggested organization and Table of Contents, but others may have suggestions for a better flow. .

Section 4.2 Heat Extremes

In contrast to NCA5, NCA4 examined heat extremes across the whole of the 20th century, pointing out that peak heat wave activity was reached in the 1930s and has decreased since then, and that recent increases are confined to areas west of the Rockies:

[The] warmest daily temperature of the year increased in some parts of the West over the past century, but there were decreases in almost all locations east of the Rocky Mountains. In fact, all eastern regions experienced a net decrease, most notably the Midwest (about 2.2°F [1.2°C]) and the Southeast (roughly 1.5°F [0.8°C]).

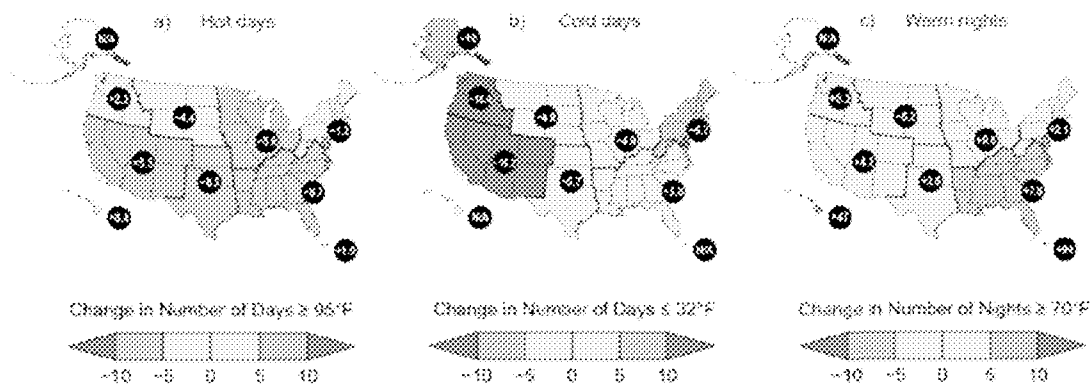
Since the mid-1960s, there has been only a very slight increase in the warmest daily temperature of the year (amidst large interannual variability). Heat waves (6-day periods with a maximum temperature above the 90th percentile for 1961–1990) increased in frequency until the mid-1930s, became considerably less common through the mid-1960s, and increased in frequency again thereafter. As with warm daily temperatures, heat wave magnitude reached a maximum in the 1930s. (NCA4 pp. 190-191)



U.S. Heat waves since 1900. Source: NCA4 Figure 6.4

Contrast this careful and factual language with NCA5 Key Message 2.2: “Extreme Events Are Becoming More frequent and Severe.” This blanket statement is followed by NCA5 Figure 2.7 reproduced below.

Observed Changes in Hot and Cold Extremes



Hot days have increased in the West, hot nights have increased nearly everywhere, and cold days have decreased.

Figure 2.7. Over much of the country, the risk of warm nights has increased while the risk of cold days has decreased. The risk of hot days has also increased across the western US. This figure shows the observed change in the number of (a) hot days (days at or above 95°F), (b) cold days (days at or below 32°F), and (c) warm nights (nights at or above 70°F) over the period 2002–2021 relative to 1901–1960 (1951–1980 for Alaska and Hawaii and 1956–1980 for Puerto Rico). Data were not available for the US-Affiliated Pacific Islands and the US Virgin Islands. Figure credit: Project Drawdown, Washington State University Vancouver, NOAA NCEI, and CISS NC.

Close inspection shows that this Figure contradicts the NCA5 Key Message with respect to heatwaves and instead reinforces the position of the NCA4. The time scale of analysis for this Figure is stated as the number of hot days, cold days and warm nights (respectively in panels a—c) over the period 2002–2021 compared to 1901–1960. Presumably (though not stated in the caption) the counts are per year. Notwithstanding Key Message 2.2 the leftmost panel shows that over most of CONUS the number of extreme heat days has decreased in recent decades compared to the prior century.

The accompanying discussion in NCA5 becomes convoluted since it appears to be aimed at supporting the Key Message despite the contrary evidence. NCA5 chapter 2 elaborates on KM2.2 by saying (p. 16):

Observations show an increase in the severity, extent, and/or frequency of multiple types of extreme events. Heatwaves have become more common and severe in the West since the 1980s (*high confidence*).

But it does not mention the decline elsewhere. On the next page (p. 17) it says:

By some measures, the most extreme heatwaves on record in the United States occurred during the Dust Bowl era of the 1930s. ... Globally such heatwaves are becoming more frequent, and in recent decades the western United States has been following those trends.

Reference to a global trend seems to be an attempt to tie heatwaves to climate change, but then the obvious question, unaddressed by NCA5, is why only part of the U.S. follows it while most of the country is trending in the opposite direction. These issues were addressed in CWG25 Ch6, demonstrating that the range and magnitude of extreme temperatures (10s of degrees) are driven more by natural variability than the small extra forcing from the enhanced concentrations of CO₂. The data shown in CWG25 shows that in terms of both (a) hot days ($\geq 95^\circ\text{F}$) and (b) number of days in heatwaves, the

current decade is experiencing no more than was experienced 100 years ago. For example, in the 30-year period 1925-1954, representing only 23% of the 1899-2024 data record, the CONUS experienced 33% of the total heat wave days. The most recent 30-years experienced 24%, almost exactly that expected by chance. Thus, the NCA5 claim that “multiday heatwaves have become hotter, more frequent, larger, and longer lasting in recent decades,” is seen to be simply false when expanding the temporal and spatial domains to encompass all available data (Ch6 Fig. 6.3.6 CWG25).

The NCA5 then pointed to the dramatic Pacific Northwest heatwave of 2021. CWG Section 8.6.1 discussed this event in detail, reviewing the findings of multiple peer-reviewed studies that explained the unusual meteorological conditions giving rise to it were unrelated to climate change, a point omitted from the NCA5 discussion.

NCA5 finally turns to the declining heatwave trend in CONUS east of the Rockies but attempts to reframe it by focusing on urban warm spells.

[The] number of very hot days has actually decreased across the central and eastern regions due to summer cooling trends in the region (Figure 2.7; Ch. 22). This does not, however, mean the central and eastern US are not affected by heat. The impacts of extreme high temperatures are more severe if such conditions persist for several days, and overall, multiday heatwaves have become hotter, more frequent, larger, and longer lasting in recent decades. Across 50 large US cities, the US Global Change Research Program heatwave indicator (<https://www.globalchange.gov/indicators/heat-waves>) shows that the average number of heatwaves has doubled since the 1980s, and the length of the heatwave season has increased from about 40 days to about 70 days.

We discussed this issue in CWG25 Section 6.3. The Figure referenced by NCA5 uses an *ad hoc* definition of heat wave, namely two consecutive days with minimum nighttime temperatures above the 85th percentile, and an *ad hoc* time scale which begins in the 1960s, the coldest decade in the last century, thus suppressing any comparison to the 1930s. Nighttime temperatures in urban areas have gone up faster than daytime temperatures (which the NCA5 acknowledges), but this is a signature of urban heat island effects and is not a good metric of climate change. CWG25 noted as well that the occurrence of hot days ($\geq 95^{\circ}$ F) has recently increased in the West, but declined in the remainder of the country, and in the nationwide average, since 1899.

The NASEM Review failed to raise any of these issues. Much of it focused on social and policy issues (e.g., Comments on Equity and Justice), rather than on the underlying science. In our assessment NASEM failed to apply the serious rigor one would expect. A few extracted comments from it will illustrate. Note that NASEM review comments are included here in blue font for reference. NASEM praised the section as a whole by saying:

The chapter [2] meets the requirements of Section 106 of the GCRA.

Yet contrary to the requirements of Section 106 the NCA5 did not discuss natural variability let alone assess the full climate record available for quantifying natural variability. Chapter 2 actually minimizes natural variability by claiming (unsubstantiated) skill in attributing recent extremes to human causes. For example NCA5’s Chapter 2 Introduction states,

“...recent advances in attribution science (KM 3.3) mean that the role of climate change in some extreme events can now be quantified in real time. For example, climate change made the record-breaking Pacific Northwest heatwave of June 2021 2° to 4°F hotter, and in 2017 ...”

CWG25 reviews the expert literature demonstrating that this particular event would have happened with or without climate change and that for the CONUS, hot extremes are no more frequent now than they were in the past. NASEM did not challenge the unsubstantiated attribution claims in the NCA5.

Notwithstanding NASEM’s claim that the section complies with Section 106 of the GCRA it then acknowledged the absence of discussion of natural variability:

...the discussion and references regarding the role of natural climate variability and its regional differences are missing.

While a nod to natural variability is occasionally found in NCA5, it is usually followed by a “however” to emphasize human influence. One example is the statement just before the claim mentioned above pertaining to extreme event attribution: “There has always been extreme weather, which occurs even in an unchanged climate due to the natural variability of the Earth system. However, recent advances in attribution science (KM 3.3) mean that the role of climate change in some extreme events can now be quantified in real time...”

We pointed out that the evidence regarding heatwaves directly contradicts Key Message 2.2. NASEM did not mention this, instead it focused on a somewhat esoteric issue of terminology:

“Extreme Events Are Becoming More Frequent and Severe.”

Key Message 2.2 is another generally well written key message. However, while the title of this key message includes the word “risk,” the key message is exclusively about hazard. The Committee suggests rewriting the key message title to more accurately reflect the discussion on hazards.

The NASEM review appears to accept the NCA5’s use of short data records because it makes no critical remarks about the failure to assess long time series, except for its observation that the use of short records makes the omission of natural variability that much more of a problem:

It is also important to point out that the influence of natural climate variability becomes particularly strong when the climate trend is computed based on short periods of time or small geographic areas.

This comment was largely ignored in the NCA5 final text.

From: John Christy <climateman60@gmail.com>
Sent: Wednesday, June 11, 2025 10:55 AM
To: Ross McKittrick
Cc: Judith Curry; Roy W. Spencer; Travis Fisher; Steven Koonin; Josh Loucks; seth.cohen@hq.doe.gov
Subject: Re: June 10 draft

Ross

Notes on version June10.

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From: Ross McKittrick [ross.mckittrick@gmail.com]
Sent: 6/11/2025 1:29:28 AM
To: Judith Curry [curry.judith@gmail.com]; Roy W. Spencer [roywspencer@hotmail.com]; John Christy [climatemanager60@gmail.com]; Travis Fisher [travis.scott.fisher@gmail.com]; Steven Koonin [steven.koonin@googlegmail.com]; Josh Loucks [loucksj14@gmail.com]; seth.cohen@hq.doe.gov
Subject: June 10 draft
Attachments: NCA5.Review.[RM].June10.docx

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Review of the Fifth National Climate Assessment

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1 INTRODUCTION

1.1 About this Report

This report responds to a request from OSTP Director Michael Kratsios (reproduced in Appendix XX) that we assess the suitability of the Fifth National Climate Assessment for informing climate and energy policies.

To conduct this assessment we reviewed NCA5 itself, NASEM review of the Third Order Draft and the USGCRP responses to the review. We have drawn upon our long experience working on advisory reports, including for the NASEM, IPCC and other organizations, as writers, reviewers and project leaders.

We find that NCA5 should not be relied on for policy making as it is an incomplete and misleading picture of our understanding of the changing climate and the risks it poses to the nation. NCA5 was selective and incomplete in its survey of the science as of its publication date in 2023 and has become even more so in the years since. We have reviewed many key scientific developments in a separate report to Energy Secretary Wright (Climate Working Group 2025, herein denoted “CWG25”). The overall effect of the biases and omissions of NCA5 is an excessively dire picture of climate risk.

Our report begins with background on the National Climate Assessments. We then discuss the standards by which we have assessed NCA5, followed by specific deficiencies that we have identified.

1.2 About the National Climate Assessments

The U.S. Global Change Research Program (USGCRP) was established by Presidential Initiative in 1989 and mandated by Congress in the Global Change Research Act (GCRA) of 1990 to develop and coordinate “a comprehensive and integrated United States research program which will assist the Nation and the world to understand, assess, predict, and respond to human-induced and natural processes of global change.”

The National Climate Assessment (NCA) Reports evolved from the GCRA requirement to

Prepare and submit to the President and the Congress an assessment which (1) integrates, evaluates, and interprets the findings of the Program and discusses the scientific uncertainties associated with such findings; (2) analyzes the effects of global change on the natural environment, agriculture, energy production and use, land and water resources, transportation, human health and welfare, human social systems, and biological diversity; and (3) analyzes current trends in global change, both human-induced and natural, and projects major trends for the subsequent 25 to 100 years.

The five NCA Reports to date have interpreted this mandate in different ways:

- NCA1 (2000) was a multidisciplinary effort to study and portray in regional detail the potential effects of human-induced global warming on the United States.
- NCA2 (2009) was a relatively short report that not only focused on the potential consequences of climate change, but also sought to identify potential adaptation measures and identify the highest priorities for future research.

- NCA3 (2014) was an expanded effort that continued along the lines of NCA2, and was distinguished by a comprehensive review process, including a review by the National Academy of Sciences.
- NCA4 (2017/2018) was an expanded effort published in two volumes: I Climate Science Special Report, and II Impacts, Risk, and Adaptation in the United States. This was the first NCA report to devote significant effort to assessing climate science. NCA4 introduced a traceability analysis for each key finding, including a cursory description of uncertainties.
- NCA5 (2023) returned to a single volume format, reducing discussion of climate science to a cursory two chapters, with continuing with a focus on regional and sectoral impacts of climate change. NCA5 expanded its remit to topics that are arguably outside the purview of the USGCRP, focusing on “Climate Action” and policy recommendations with a social justice emphasis. NCA5’s self-description is reproduced as Appendix II.

These successive interpretations of the NCA are poorly aligned with the GCRA’s statutory requirements. Only NCA4 gives serious consideration to climate science, which receives the great majority of USGCRP funding, and even then misrepresents some important points (see the Box nearby for an example). Natural climate variability is essentially dismissed as unimportant in NCA4 and barely mentioned in NCA5 in most contexts, despite the mandate to include both human-caused and natural climate change. Most significantly, NCA5 has redirected the focus away from climate science and even the hazard elements of impacts, towards evaluation of societal vulnerabilities and advocacy for particular policy options, especially wind and solar power. The cover image for the NCA5 Report is the installation of a solar panel.

1.3 Standards for Assessing NCA Products

In Appendix XX we include a letter of guidance from the Office of General Counsel, U.S. Department of Energy, summarizing the extent of statutory requirements governing USGCRP work products in general and NCA products in particular.

We can summarize the standards applicable to the NCA as follows:

- details.

Beyond the statutory requirements we draw attention to two other pertinent standards. President Trump’s executive order of May 23, 2025, “Restoring Gold Standard Science” enumerates some of the characteristics of good science:

- i. reproducible;
- ii. transparent;
- iii. communicative of error and uncertainty;
- iv. collaborative and interdisciplinary;
- v. skeptical of its findings and assumptions;
- vi. structured for falsifiability of hypotheses;
- vii. subject to unbiased peer review;
- viii. accepting of negative results as positive outcomes; and
- ix. without conflicts of interest.

Although these should be self-evident to those trained in science, it is surprising that some have found them controversial.

We consider that when scientific reports are being assembled that will be highly influential on climate policymaking there are other desiderata, including statements about the strength of climate knowledge. The IPCC's approach is based on judgment of the available evidence and agreement among experts. More sophisticated knowledge characterizations for risk management include: REFERENCE AVEN

- The degree to which the assumptions made are reasonable/realistic based on background knowledge—concern about the focus on implausible emissions scenarios RCP8.5/SSP5–8.5
- The degree to which data/information exists and are reliable and relevant—the historical and paleo database is inadequate for a complete characterization of natural climate variability on multi-decadal to millennial time scales
- The degree to which there is disagreement among experts (including those from different environments or academic fields)—attempts to suppress disagreement and alternative perspectives among experts
- The degree to which the phenomena involved are understood and accurate models exist—concerns about the fidelity and utility of climate models
- The degree to which the knowledge has been thoroughly examined with respect to unknown knowns and—neglect of the unknown knowns associated with natural climate variability

Good climate and energy policies will balance the risks and benefits of a changing climate against the world's growing demand for reliable and affordable energy. To strike that balance, policymakers must understand at least two complex and nuanced topics: the certainties and uncertainties of climate science and the technoeconomic realities of energy systems. Experts in those subjects have a unique responsibility to communicate their understanding to non-experts clearly, completely, and without bias.

Expertise in energy systems resides largely in the private sector, where it is essential to providing the reliable and affordable energy services that are the lifeblood of society. Understanding is therefore continually refined and tested by the discipline of the marketplace. In contrast, climate science expertise is found largely in the non-profit realm of universities and government laboratories and so has a more academic character.

Because climate is at the core of human existence, it can engender passion and emotion. Indeed, some younger climate scientists have gone into the field to "save the planet." So it isn't surprising that objectivity can suffer when climate scientists communicate their understanding to non-experts. Further, the field of climate science has been politicized by NetZero mandates. This lack of objectivity usurps the public's right to make informed choices and undermines their confidence in the scientific enterprise.

Philip Handler, President of the National Academy of Sciences, identified the problem in a 1980 editorial that resonates eerily four decades later:

Difficulty arises in the scientific community from confusion of the role of scientist *qua* scientist with that of scientist as citizen, confusion of the ethical code of the scientist with the obligation of the citizen, blurring the distinction between intrinsically scientific and intrinsically political questions. When scientists fail to recognize these boundaries, their own ideological beliefs, usually unspoken, easily becloud seemingly scientific debate.

1.4 When Peer-Review Fails: An Example from NCA4

Peer-review of reports like IPCC and NCA products is not a silver bullet that guarantees quality. The peer review process for these reports differs in some important respects from traditional peer review in academic journals. First, NCA reviewers self-select on a volunteer basis whether to provide comments and what parts of the report to read, whereas in academic journals Editors recruit reviewers and assign them to specific papers. There is no guarantee that any particular section of an NCA report was reviewed by anyone, let alone by someone with a different perspective than the authors. This is a problem with NCA and IPCC reports since over the years many potential reviewers have given up making the effort, because their input has systematically been ignored. Second, and related, NCA authors have near complete authority whether to accept or reject review comments. Here, for example, is how a review comment critical of a section of the NCA5 draft was handled by the authors:

REVIEWER COMMENT

Tropical Cyclones/hurricanes have not increased (Klotzbach, P.J., Bowen, S.G., Pielke, R. and Bell, M., 2018. Continental US hurricane landfall frequency and associated damage: Observations and future risks. *Bulletin of the American Meteorological Society*, 99(7), pp.1359-1376., Pielke, R., 2021. Economic Anormalisation, A def disaster losses 1998, A 2020: A literature review and assessment. *Environmental Hazards*, 20(2), pp.93-111.)

US NCA RESPONSE

Thank you for your comment.

This comment is inconsistent with the author team's thorough assessment of the science.

By contrast in academic journals the Editor mandates the authors' response and the reviewer gets to assess its adequacy. Third, once an NCA chapter author team has been selected publication of their work is guaranteed, whereas academic journals routinely reject papers if they do not pass review.

These points are important to bear in mind because some readers might dismiss any criticism of NCA products out of hand on the grounds that they were "peer reviewed". But the test of a report is whether its contents are a valid representation of the available evidence. Here we give an example in which NCA4 gave prominence to a Figure that completely misrepresented the underlying data and which evaded peer review to do so. Further details can be found in Koonin (2024).

As we pointed out in CWG25 Section 6.3 the number of heat extremes in the U.S. peaked in the 1930s and has declined ever since. Taking cold and hot extremes together the U.S. climate has become more moderate over time. NCA4's Part I (Climate Science Special Report, CCSR) says (prominently and with *Very High Confidence*) on Page 19 of the Executive Summary:

There have been marked changes in temperature extremes across the contiguous United States. The number of high temperature records set in the past two decades far exceeds the number of low temperature records.

and offers this figure in support:

Record Warm Daily Temperatures Are Occurring More Often

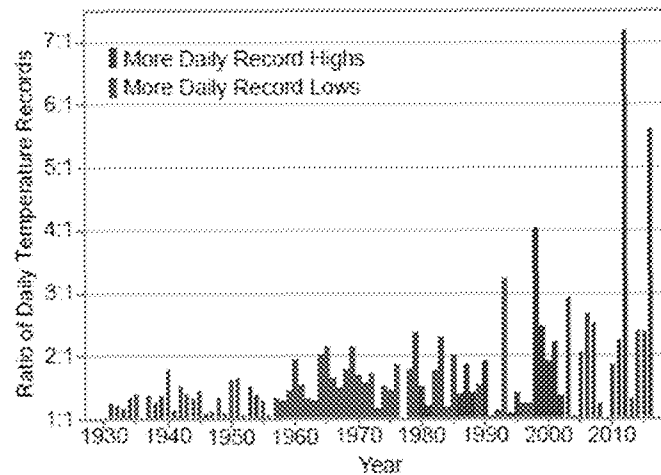
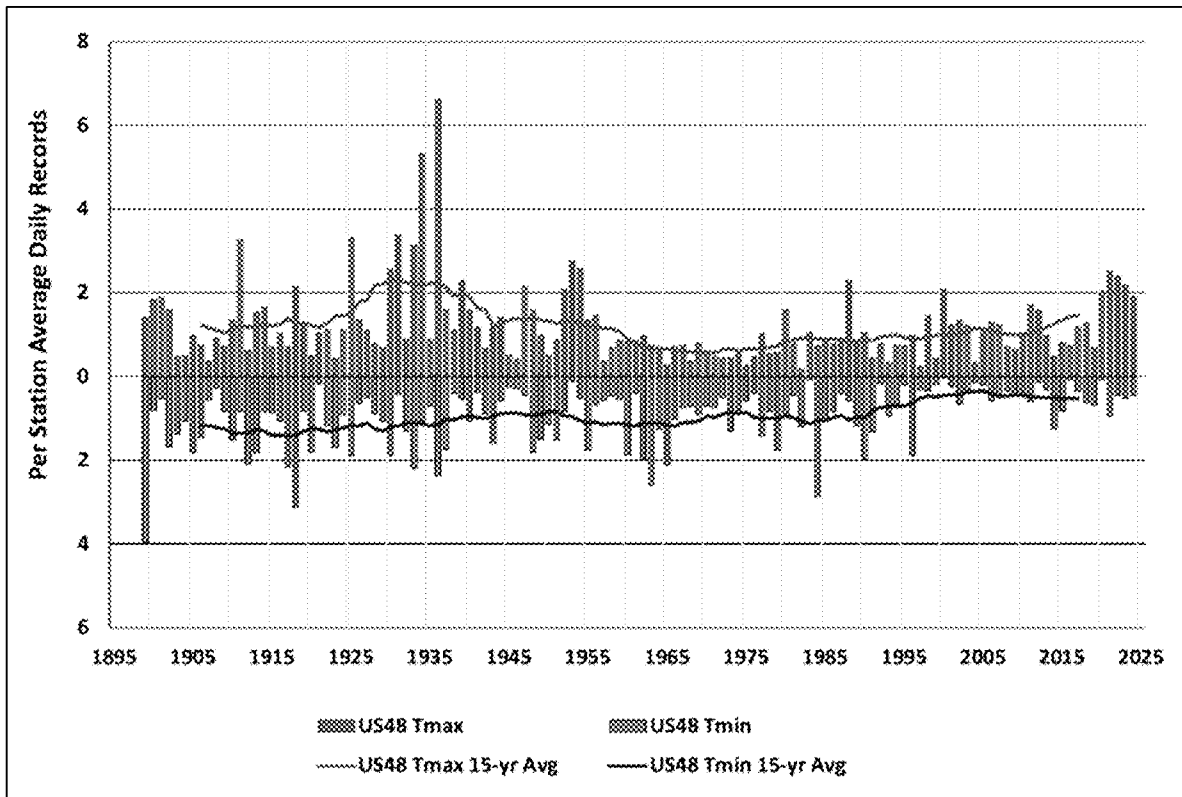


Figure ES.5: Observed changes in the occurrence of record-setting daily temperatures in the contiguous United States. Red bars indicate a year with more daily record highs than daily record lows, while blue bars indicate a year with more record lows than highs. The height of the bar indicates the ratio of record highs to lows (red) or of record lows to highs (blue). For example, a ratio of 2:1 for a blue bar means that there were twice as many record daily lows as daily record highs that year. (Figure source: NOAA/NCEI). From Figure 6.5 in Chapter 6.

The Figure appears to validate the claim that, as the title says, record warm daily temperatures are occurring more often. But the underlying data do not: they show that extreme heat in the U.S. peaked in the 1920s and 1930s and declined thereafter, as NCA4 Figure 6.4 later shows. Figure ES.5 does not show what its title implies: these are not simple counts of cold and warm extreme events, instead they are ratios of the two. In fact both types of extremes declined over the sample interval, but cold events declined more than warm events, so the ratio of warm extremes to cold extremes went up. By graphing the ratio in this way the NCA4 created a visual impression opposite to what is in the data.

Figure 6.3.3 of CWG25 (reproduced below) shows the results of a proper analysis – defining each record as the singular extreme in the history, displaying numbers of warm and cold records separately, and beginning the analysis in 1899 rather than 1930. It makes evident the exceptional heat of the 1920s and especially the 1930s, peaking in 1936. The increased heat of the past five years is too brief to be deemed climatically significant and, in any event, occurred after the CSSR was published in 2017. The frequency of cold records has declined, especially over the last quarter of the period in which only 13 percent of the extreme cold events were measured. In contrast, 25 percent of the extreme Tmax records were achieved in the last quarter, which is consistent with statistical expectations. As a result, the ratio shown in the CSSR explodes in recent decades. The overall reduction in numbers of both cold and hot extremes over the past century indicates a climate *less* prone to extremes, in sharp contrast to the message of the NCA4 Figure.



Number of daily record High (red) and Low (blue) temperatures for warm and cold seasons in the CONUS. The lines represent the 15-year running, centered average. Source: 1,211 USHCN stations supplemented as needed to achieve a minimum of 92 percent of observations in the 126-year period since Dec 1898. US48: contiguous U.S. states. Tmax: maximum temperature. Tmin: minimum temperature. Source: CWG25 Figure 6.3.3.

The National Academies' expert review panel criticized the discussion of temperature extremes in a late draft of the CSSR. In reference to the CSSR's Key Finding 2 of Chapter 6, they said:

Further, it is difficult to understand how a statement that includes increases in extreme warmth can be associated with a high confidence or extremely likely statement, given that most of the graphics in this chapter show a decrease in extreme warmth in the historical record.

The Federal official in charge of the CSSR (Michael Kuperberg, Executive Director of the USGCRP) responded to the Academies' review by noting that

Almost every recommendation from the NAS was incorporated [in the final version]... and a new figure was added on changes in record high and low temperatures

The "new figure" referred to is the Figure ES.5, which did not appear in the draft reviewed by the Academies' panel. It seems unlikely that the Academies panel ever saw that figure because they surely would have commented if they had and it wouldn't have survived to publication. And the figure's problems were evidently not flagged (or were ignored) in the subsequent internal government reviews.

With this background we now present our critique of NCA5.

2 OVERVIEW CHAPTER: HYPERBOLIC ADVOCACY LANGUAGE AND NON-SCIENTIFIC TONE

The opening Chapter 1 “Overview” holds a prominent place since it summarizes the whole report and is the only section that many will read. Although the later Chapters of NCA5 contain much sound scholarly content, Chapter 1 is marred by a pervasive tone and language aggressively promoting emission reduction policies. The authors must have known this chapter would be mined for quotes by the media and activists looking to add an imprimatur of scientific authority to oversimplified declarations of opinion. Many examples can be cited; here we note a few that are particularly egregious.

Chapter 1 opens as follows:

The more the planet warms, the greater the impacts. Without rapid and deep reductions in global greenhouse gas emissions from human activities, the risks of accelerating sea level rise, intensifying extreme weather, and other harmful climate impacts will continue to grow. Each additional increment of warming is expected to lead to more damage and greater economic losses compared to previous increments of warming, while the risk of catastrophic or unforeseen consequences also increases.

This statement presupposes all warming is anthropogenic in origin, all warming is bad and causes economic damage, warming causes extreme weather to intensify. Such sweeping generalizations go well beyond what science has or can establish. A scientifically-sound version of this paragraph would instead say something like the following:

The Earth is warming because of a combination of natural and anthropogenic influences. This warming will generate a mix of benefits and harms that varies by region, to which society should be prepared to adapt. Some types of extreme weather have worsened recently, while others have not changed or have even declined in intensity. Reducing emissions of greenhouse gases might slow the warming although such policies have proven to be costly and disruptive, so any climate actions to be weighed against the potential benefits.

On the next page the Overview goes on to say:

Each additional increment of warming leads to greater risks [here it lists 7 key components of society including food security and the economy]... Without deeper cuts in global net emissions, climate risks to the US will continue to grow... Action to limit future warming and reduce risks can have near-term benefits and opportunities: low-carbon energy jobs, Improved air quality, Health benefits, Economic benefits...”

The authors write as if climate policy does not involve trade-offs and all measures to reduce future warming will be effective and beneficial. But the vast body of scholarship on climate science and economics does not support such simplistic claims. Not every additional increment of warming leads to economic harms, indeed (as is acknowledged in Chapter 19 on Economics) in some cases there will be benefits. Nor is climate policy guaranteed to create jobs or benefit the economy; in many cases it has done the opposite. Such deceit is a disservice to policymakers.

Page 9 promotes renewable energy options by noting, correctly, that the levelized costs of wind/solar generation have fallen sharply since 2010. Yet it has long been known that intermittent renewables generation must be supplemented by dispatchable generation to meet grid reliability standards, and that doing so (e.g., through gas, fission, or storage) more than doubles the cost of electricity. Further, there are yet unmet synchronization challenges in wind/solar-heavy grids. Here again it is advisory malpractice not to acknowledge these facts.

Page 14 presents future emission scenarios with the following description: “Climate modeling experts develop global climate projections for a range of plausible futures.” The word “plausible” is applied to all the scenarios. The accompanying Figure includes both SSP3-7.0 and SSP5-8.5, the latter reaching the same radiative forcing as RCP8.5. The figure does not contrast observed emissions against previous projections nor does it caution readers that SSP3-7.0 and SSP5-8.5 are extreme worst case scenarios that, like RCP8.5, have been heavily criticized in the scientific literature (CWG25 3.2.1). By describing the entire envelope of emission projections as “plausible” the report opens the door to later presenting impacts associated with extreme and implausible emission scenarios as part of a baseline “business-as-usual” future.

[We could criticize Figure 1.6, which uses an anecdote to support its 1200 claim.]

Page 17 (and elsewhere) invokes the NOAA Billion Dollar Dataset as an indicator of extreme weather getting worse. Scientists have shown that this is an invalid metric (CWG 10.2) since it measures the growth of the economy not the frequency of extreme weather, and indeed NOAA has withdrawn the data product. Even though it was still distributed by NOAA at the time of the NCA5, the report authors should have assessed it skeptically and seen that it was unfit for the purpose of measuring climate trends.

Page 23 states, in large font:

Climate changes are making it harder to maintain safe homes and healthy families; reliable public services; a sustainable economy; thriving ecosystems, cultures, and traditions; and strong communities.

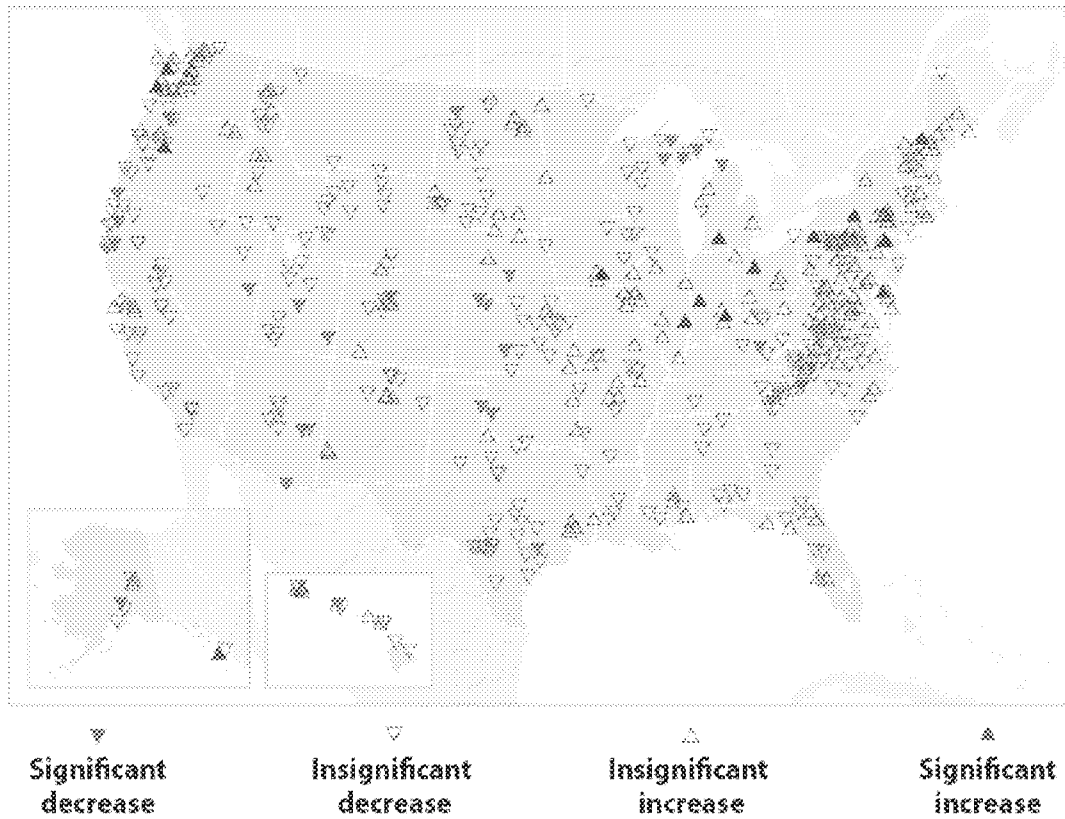
It is pointless to try to evaluate this statement on scholarly grounds; it is self-evidently hyperbolic. This kind of language doesn’t belong in a scientific assessment report. Its prominent inclusion points not only to the willingness of NCA5 authors to promote hysteria, but also the ineffectiveness of the review process at not ensuring such statements are removed.

We won’t try to cite all the remaining examples of advocacy and hyperbole in the Overview chapter; one more example will suffice. Page 26 states “Increasing flooding puts more people and assets at risk.” The accompanying figure contrasts model-projected flood losses by county in 2050 to that observed in 2020 as estimated in Wing *et al.* (2022)¹. Hence the evidence for the claim is not currently-observed trends, it is a model-generated projection of changes. But current trends in U.S.-based flooding reveal a more complex picture with a general overall trend towards less flooding. The Environmental Protection Agency’s “Climate Change Indicators: River Flooding” webpage² shows maps both of flood magnitude and frequency. Both show more regions experiencing declines over

¹ Wing, Oliver, William Lehman, Paul Bates *et al.* (2022) Inequitable patterns of US flood risk in the Anthropocene. *Nature Climate Change* 12 156—162 <https://www.nature.com/articles/s41558-021-01265-6>

² <https://www.epa.gov/climate-indicators/climate-change-indicators-river-flooding>

1965-2015 than increases. Hence current trends indicate generally declining U.S. flood risks, but the NCA5 Overview not only fails to mention this but declares the opposite based on a single study presenting model-generated forecasts of flood activity decades in the future.



U.S. Flood magnitude trends 1965-2015.

Source: <https://www.epa.gov/climate-indicators/climate-change-indicators-river-flooding>

3 OVERCONFIDENCE WHEN STATING CONCLUSIONS

3.1 Inflated certainty levels

A general pattern in the NCA5 is overconfidence in stating conclusions. The authors frequently make sweeping generalizations without appropriate caveats or acknowledging uncertainties. The overconfidence begins with inflated certainty levels.

The NCA5 uses specific terms to convey information about scientific confidence associated with important finds, observations and projections. The Front Matter of the NCA5 states that “confidence in a finding is based on the type, amount, quality, strength, and consistency of evidence; the skill, range, and consistency of methods to detect, evaluate, attribute, and interpret climate trends; and the degree of agreement across scientific information sources.”

Table 1 provides calibrated language for confidence assessment:

Very high:	Strong evidence (established theory, multiple sources, well documented and accepted methods, etc.). High consensus
High:	Moderate evidence (several sources, some consistency, methods vary and/or documentation limited, etc.). Medium consensus
Medium:	Suggestive evidence (a few sources, limited consistency, methods emerging, etc.) Competing schools of thought.
Low:	Inconclusive evidence (limited sources, extrapolations, inconsistent findings, poor documentation and/or methods not tested, etc.). Disagreement or lack of opinions among experts.

This terminology is inflated: *high confidence* with just moderate evidence and medium consensus; *medium confidence* with only suggestive evidence and competing schools of thought. This inflation in terminology leads to overconfidence in the conclusions.

Even within the context of this inflated terminology, NCA5 further inflates the confidence level of many of its conclusions to well beyond what the IPCC has concluded with more thorough justification, and also by incorrectly applying its own standards. Several illustrative examples are provided.

Key Message 3.1 Traceable Account states: “There is *very high confidence* that emissions of GHGs from human activities, fossil fuel use in particular, have unequivocally caused *all* global warming observed over the industrial era.” Compare this statement with statements from the IPCC AR5 and AR6:

AR5: “It is *extremely likely* that *more than half* of the observed increase in global average surface temperature from 1951 to 2010 was caused by the anthropogenic increase in greenhouse gas concentrations and other anthropogenic forcings together.” (IPCC, 2013)

AR6: “The *likely* range of total human-caused global surface temperature increase from 1850–1900 to 2010–2019 is 0.8°C to 1.3°C, with a best estimate of 1.07°C. It is *likely* that well-mixed GHGs contributed a warming of 1.0°C to 2.0°C, other human drivers (principally aerosols)

contributed a cooling of 0.0°C to 0.8°C, natural drivers changed global surface temperature by –0.1°C to +0.1°C, and internal variability changed it by –0.2°C to +0.2°C. It is *very likely* that well-mixed GHGs were the main driver of tropospheric warming since 1979.” (IPCC, 2021)

The IPCC AR5 and AR6 statements provide likelihood assessments but not a confidence level. While the NCA5 claims with *very high confidence* that fossil fuels have unequivocally caused *all* global warming, the AR5 refers to “*more than half* of the observed warming” and the AR6 provides a more nuanced statement that relates to a *likely* range of warming contributed to by human drivers.

NCA5 Key message 2.2: “Hurricanes have been intensifying more rapidly since the 1980s (*high confidence*) and causing heavier rainfall and higher storm surges (*high confidence*).” No justification is provided in Chapter 2 for the *high confidence* conclusion on higher storm surges or hurricanes causing heavier precipitation. The Traceable Accounts section, Description of Confidence and Likelihood states: “Basic physical understanding and climate models both provide robust explanations for the links between climate change and observed changes in these extremes: this is why the authors also have *high confidence* that storms are delivering more rainfall and high confidence that storm surges are becoming higher.” In short, the NCA5 provides no observational basis or published research for their *high confidence* assertions that hurricanes are causing heavier rainfall and higher storm surges; and does not meet its own standards for a *high confidence level*.

3.2 Range of climate sensitivity

Chapter 3 (Earth System Processes) states, on page 3-10, Key Message 3.2: “The Estimated Range of Climate Sensitivity Has Narrowed by 50%”. Referring to Equilibrium Climate Sensitivity (ECS) the section elaborates:

Recent improvements in the understanding of how climate feedbacks vary across timescales have narrowed the estimated *likely* range of warming expected from a doubling of atmospheric carbon dioxide by 50% to between 4.5°F and 7.2°F (*high confidence*).... This uncertainty reduction results from advances in combining observations and targeted modeling results from nearly independent lines of evidence, each of which generally agrees on the values of ECS. The lines of evidence include 1) observed present-day variations on monthly to interannual timescales from which cloud and other climate feedbacks are inferred; 2) observed temperature changes between the preindustrial period and present and associated relationships to ERF; and 3) estimated temperature and radiative forcing changes for multiple warm and cold periods in paleoclimate records.

The graphic summary on page 3-11 states

The reduced uncertainty in climate sensitivity and climate feedback has been achieved through unprecedented quantitative synthesis of evidence from observed changes over recent decades, the industrial era, and paleoclimate.

This is a grossly inadequate description of the situation. The key development in AR6 was a *reduction* of confidence in the ability of climate models to identify ECS and the shift away from the model-based method the IPCC had relied on since AR1 in 1990. The IPCC instead turned to data-driven ECS

estimation and specifically chose a single paper from the scientific literature, Sherwood *et al.* (2020³) for the purpose. It combined paleoclimate data, modern instrumental data and modern observations of climate processes, mainly cloud-related, that govern key feedbacks. Sherwood *et al.* used a subjective Bayesian method to determine the likely range of ECS values. The Bayesian approach begins with the researcher specifying a “prior”, namely an expectation of the likely distribution of answers before seeing the data. In this case the prior consists of an expected ECS range based on the researchers’ subjective beliefs. Then the data are allowed to influence the ECS distribution and the final result is a weighted average of the assumed prior and the data-driven result. Sherwood *et al.* found a best (or median) ECS estimate of 5.4°F (3°C), which was close to previous model-based estimates but raised the likely lower bound by 1.7°F from 2.5°F to 4.2°F. The IPCC accepted this result and increased the best estimate to 3.1°C.

The NCA5 was published in November 2023. Well before that, in September 2022, Lewis (2023) had been published online at *Climate Dynamics* presenting a forceful critique of Sherwood *et al.*⁴ One of Lewis’ points was that Sherwood *et al.*’s result was dependent on their chosen subjective prior. Lewis recommended using an objective Bayesian method, which places primary weight on the data rather than the researcher’s expectation. Using that and updated forcing data from AR6, Lewis estimated an ECS best estimate of 4.0°F (2.2°C) with a likely lower bound of 2.9°F (1.6°C).

Hence, in contrast to the promotional language of Chapter 3 a more valid summary of the ECS literature as it stood at the time of writing the NCA5 would be what we wrote in CWG25 (emphasis added):

For the AR6, the IPCC placed primary weight on the results of Sherwood *et al.* (2020) that combined historical and paleoclimate proxies with the process-based approach and yielded a best estimate of 3.1°C with a *likely* range of 2.6-3.9°C. Lewis (2022) raised a number of concerns about this result, including methodological errors, outdated input values, and use of subjective versus objective Bayesian priors in the analysis. Lewis’ analysis found that climate sensitivity is estimated to be much lower and better constrained than in the Sherwood *et al.* analysis – median 2.2°C (1.8–2.7°C in the 17–83 percent *likely* range, and 1.6–3.2°C in the 5–95 percent *very likely* range). **The IPCC AR6 estimated only a 5 percent probability that ECS was below 2.3°C, whereas Lewis estimated it to be over 50 percent.** The most recent publications on the debate between Sherwood *et al.* and Lewis further defend their respective positions: Sherwood and Foster (2024) and Lewis (2025).

3.3 New emission scenarios as a scientific “advance”

Chapter 3 pp. 13-14 treats the release of new emission scenarios as a scientific “advance” without addressing the failure of many previous scenarios to match reality or providing an honest assessment of the likelihood that the new ones remain biased in the same way.

³ Sherwood, S. C., Bony, S., Boucher, O., Bretherton, C. S., Forster, P. M., Gregory, J. M., & Stevens, B. (2020). An assessment of Earth’s climate sensitivity using multiple lines of evidence. *Reviews of Geophysics*, 58(4). <https://doi.org/10.1029/2019rg000678>

⁴ Lewis, N. (2023). Objectively combining climate sensitivity evidence. *Climate Dynamics*, 61(9–10), 3155–3163. <https://doi.org/10.1007/s00382-022-06398-8>. The final citation for this paper is Lewis (2023) because the print edition did not appear until 2023, but the article was accepted in August 2022 and the online edition appeared and was in circulation in September 2022.

Key Message 3.3 states “New Data and Analysis Methods Have Advanced Climate Science” and includes the following:

New scenarios of socioeconomic development, and their associated emissions and land-use changes, drive updated climate projections from Earth system models. The Scenario Model Intercomparison Project (ScenarioMIP) organized the main set of 21st-century projection experiments under the latest phase of the Coupled Model Intercomparison Project, CMIP6. These CMIP6 projections used newly developed scenarios based on Shared Socioeconomic Pathways (SSPs; Figure 3.4). Five SSPs represent alternative plausible trajectories of 21st-century GDP and population growth and the pace and pervasiveness of socioeconomic and technological progress within individual nations and across the world (see Table 3 in the Guide to the Report). SSP-specific drivers are used in integrated assessment models (IAMs) to simulate the corresponding evolution of the energy system and the resulting greenhouse gas trajectories. These are in turn used by ESMs to drive their 21st-century projections.

There is nothing wrong with NCA5 discussing the development of new emission scenarios which serve as inputs to climate change projections and impact studies. But it is a serious omission not to inform the reader of the failure of many previous IPCC scenarios to match reality and the tendency of the scenario groups to exaggerate near-term and long-term CO₂ concentration growth (CWG25 3.2.1). It is also a serious omission not to caution readers that many climate impact studies use RCP8.5 which by the time of NCA5 had already been heavily criticized in the literature.

The same section also reports the availability of new and larger model ensembles as a scientific advance, without addressing ways in which models are getting worse in some key respects (CWG Ch 5).

3.4 “Emergent Constraints” and uncertainty in climate projections

Chapter 3 page 17 presents the topic of “emergent constraints” in uncritical terms:

An approach to reduce uncertainty in climate change projections has matured over the past decade. It is known as “emergent constraints.” The term refers to strong statistical relationships between highly uncertain future climate parameters and observable trends or variations in the current climate, along with a physical explanation of this relationship.

Emergent constraints appeared in the climate modeling literature as a way to tie GCM behavior to climate observations in hopes of generating insight into real-world ECS. Climate models exhibit a wide range of sensitivities. The idea of emergent constraints is to examine whether the models with shared sensitivity values also share a common representation of some climate process (usually related to clouds) that might indirectly influence ECS. Suppose, for instance, that in low-ECS models the total cloud fraction in the tropics is strongly correlated with that in the southern midlatitudes but in high-ECS models the correlation is weak. Then researchers could check if the observed correlation is strong or weak and draw a conclusion about which type of model, and therefore which ECS value, is more likely.

A problem in the emergent constraint literature is that there has been a large proliferation of proposed correlations with little physical motivation. Many emergent constraints patterned on

CMIP5 models failed to work on CMIP6 models (Schlund *et al.* 2020)⁵. In other words, the observed correlations in CMIP5 models between ECS and cloud processes failed to show up in CMIP6 models, indicating that they were likely spurious rather than clues to physical processes governing the Earth climate system. The result was that emergent constraints estimated on CMIP5 models widened the range of estimated ECS values when applied to CMIP6 models.

Schlund *et al.* summarized the problem as follows:

In this study, we systematically analyze 11 published emergent constraints on ECS that have mostly been derived from models participating in the Coupled Model Intercomparison Project Phase 5 (CMIP5) project... The focus of the study is on testing if these emergent constraints hold for [Earth System Models] participating in the new Phase 6 (CMIP6). Since none of the emergent constraints considered here have been derived using the CMIP6 ensemble, CMIP6 can be used for cross-checking of the emergent constraints on a new model ensemble. **The application of the emergent constraints to CMIP6 data shows a decrease in skill and statistical significance of the emergent relationship for nearly all constraints, with this decrease being large in many cases.** Consequently, the size of the constrained ECS ranges (66% confidence intervals) widens by 51% on average in CMIP6 compared to CMIP5.

Yet NCA5 described the use of emergent constraint analysis as a great “advance” that reduced uncertainty.

3.5 Increasing hurricane intensity

NCA5 Key message 2.2 states

Hurricanes have been intensifying more rapidly since the 1980s (*high confidence*) and causing heavier rainfall and higher storm surges (*high confidence*).

No justification is provided in Chapter 2 for the *high confidence* conclusion on higher storm surges or hurricanes causing heavier precipitation. The Traceable Accounts section, Description of Confidence and Likelihood states:

Basic physical understanding and climate models both provide robust explanations for the links between climate change and observed changes in these extremes: this is why the authors also have *high confidence* that storms are delivering more rainfall and high confidence that storm surges are becoming higher.

In short, the NCA5 provides no observational basis or published research for their *high confidence* assertions that hurricanes are causing heavier rainfall and higher storm surges; and does not meet its own standards for a *high confidence level*.

⁵ Schlund, Manuel, Axel Lauer, Pierre Gentine, Steven C. Sherwood, and Veronika Eyring (2020) Emergent constraints on equilibrium climate sensitivity in CMIP5: do they hold for CMIP6? *Earth System Dynamics* 11 1233-1258 <https://doi.org/10.5194/esd-11-1233-2020>

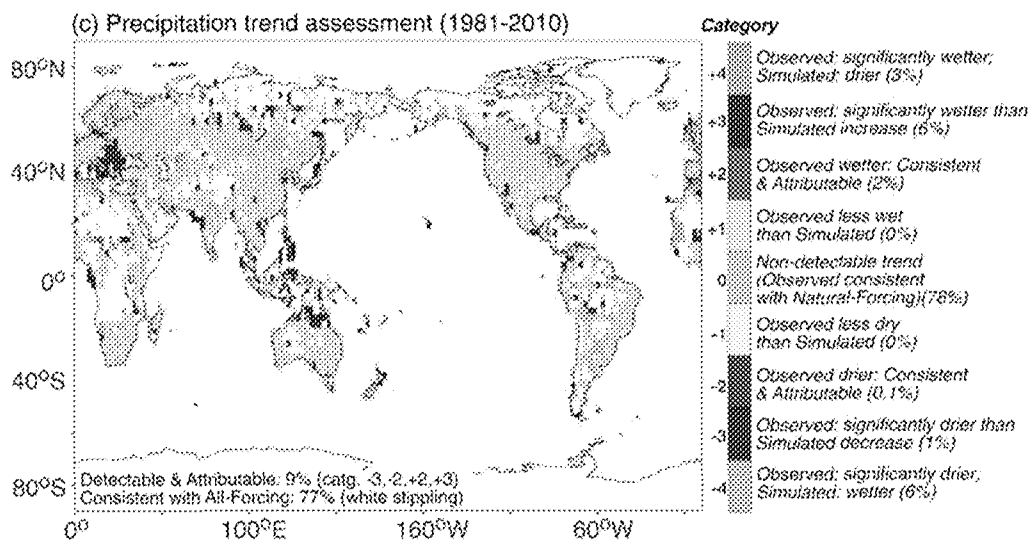
3.6 Overstating findings in underlying sources

Although we did not do a detailed audit of the NCA5's use of source material, a few spot checks turned up evidence of a pattern of overstatement.

Chapter 2 page 11 reports on an increase in precipitation in central and eastern US based on a comparison of 2002-2021 average rainfall to the average over 1901-1960. Note that this is a non-standard metric; we will discuss NCA5's inconsistent choices of time scales of analysis below. The change in this case is called a "trend" even though this is not how a trend is measured, and says that it is "attributable to climate change". The claims were attributed to the following paper:

- Knutson, Thomas and Fanrong Zeng (2018) "Model Assessment of Observed Precipitation Trends over Land Regions: Detectable Human Influences and Possible Low Bias in Model Trends" *Journal of Climate* 31(12)
<https://journals.ametsoc.org/view/journals/clim/31/12/jcli-d-17-0672.1.xml>

But Knutson and Zeng did not say these things. It examined linear trends over 1901 – 2010, 1951 – 2010 and 1981 – 2010. It did not compare average rainfall over 2002 - 2021 to average rainfall over 1901 – 1960, indeed it was published in 2018 so it could not have. With regard to 1981-2010 trends its results were summarized in the following figure:



Gray indicates no trends detected. Stippling means that there were no trends in the models either so the models and observations agreed in that respect. Detectable and attributable trends were found over only 9% of the land surface of the Earth. Over the US there are detectable trends over only a few regions in the Southwest.

Chapter 2 page 18 states

There is robust evidence that human-caused warming has contributed to increases in the frequency and severity of the heaviest precipitation events across nearly 70% of the US.

This is attributed to two papers:

- Diffenbaugh, N.S., D. Singh, and J.S. Mankin, 2018: Unprecedented climate events: Historical changes, aspirational targets, and national commitments. *Science Advances*, **4** (2), 3354. <https://doi.org/10.1126/sciadv.aao3354>

and

- Kirchmeier-Young, M.C. and X. Zhang, 2020: Human influence has intensified extreme precipitation in North America. *Proceedings of the National Academy of Sciences of the United States of America*, **117** (24), 13308-13313. <https://doi.org/10.1073/pnas.1921628117>

Diffenbaugh et al. presented ratios of observed occurrences of extreme events to simulated occurrence rates in CMIP6 models run with only natural forcings. They report that for 79% of the U.S. extreme rainfall event frequencies are currently higher than in model simulations, and the ratio of occurrences will rise under future warming simulations. This is not “robust” evidence of anthropogenic influence since it requires readers to assume that climate models provide accurate simulations of regional precipitation patterns, something which even the IPCC AR6 admits is uncertain (AR6 WGI SPM Box SPM 1.2, SPM Section C.1.3).

Kirchmeier-Young and Zhang looked at extreme 1- and 5-day events in North America and, using 3 GCMs, found “A signal of combined anthropogenic and natural external forcing can be detected in the intensification of extreme precipitation at the continental scale over North America. In some cases, this intensification can be attributed to human influence specifically.” However, they noted large differences among the three models in their simulated precipitation changes. Also, 2 of the 3 models failed to yield detection for Rx5Day for the North America mean. Finally, the authors used Total Least Squares, an estimation method known to overstate signal detection results (CWG Section 8.3.2). Here again this is not “robust” evidence, it is suggestive but other studies have found natural variability predominant. Both cited references utilized the implausible RCP8.5 scenario and began their “historical” observational records only in 1961.

4 RELIANCE ON *Ad Hoc* TIME SCALES FOR TREND ANALYSIS

In CWG25 Chapter 6 we discussed the need to be careful regarding the choice of time scale when making claims about trends in extreme weather. We gave examples from analysis of river flooding (6.1), heatwaves (6.3) and extreme precipitation (6.4) to show how assertions about apparent trends based on short data sets fall apart when looking at longer versions of the same data sets. Here we elaborate on these examples to illustrate a general point that NCA5 made inconsistent and *ad hoc* choices about time scales of analysis, weakening the validity of their conclusions.

4.1 Average and Extreme Precipitation

McKittrick and Christy (2019)⁶ showed that apparently significant positive trends in U.S. average and extreme precipitation over the NCA4 interval (1901 – 2016) disappeared on longer samples (extending back as far as the 1840s depending on location or on a shorter interval coinciding with the final 40 years of the data then available (1978 – 2017).

In CWG Section 6.4 we presented analysis of updated data for the same locations and many more besides, in all cases finding considerable regional heterogeneity and lack of robustness of trends to use of long samples.

NCA5 did not continue the NCA4 precedent of using the post-1901 interval as the time scale for its precipitation discussion, instead it refers to changes “since the 1950s” which we take to mean 1950 onwards though NCA5 Fig. 2.8 suggests 1958 as the start date. For the present report we have extended the analysis even further now to include 141 stations across the US in the Pacific Coast, Midwest, Northeast and Southeast regions. We provide details in the Appendix; here we note merely that once again it is possible to find trends that support the NCA5 position, but they are not robust to selecting longer or shorter time scales of analysis. Data from 1950 to 2024 yields many indications of increased average and extreme precipitation at individual stations and region-wide averages. But when using the entire data set (back to the 1890s or earlier depending on location) or the later subset (1980 to 2024) the trends become smaller, in many cases they become statistically insignificant, and occasionally they change sign. Only in the Northeast region are the post-1950 trends robust to focusing on the post-1980 interval.

Under Key Message 2.2 “Extreme Events Are Becoming More Frequent and Severe” (p. 2-16) NCA5 states (p. 2-18):

“Rainfall is becoming more extreme”

Since the 1950s, there has been an upward trend in heavy precipitation across the contiguous US. This increase is driven largely by more frequent precipitation extremes, with relatively smaller changes in their intensity. The largest increase in the number of extreme precipitation days (defined as the top 1% of heaviest precipitation events) has occurred over the Northeast (an increase of around 60%) and Midwest (around 45%), along with increases of more than 10% in their annual and 5-year maximum amount

⁶ McKittrick, R., and J.R. Christy (2019). Assessing changes in US regional precipitation on multiple time scales. *Journal of Hydrology*, 578, 124074. <https://doi.org/10.1016/j.jhydrol.2019.124074>

(Figure 2.8). These changes have contributed to increases in river and stream flooding in these regions. The increase in frequency and intensity of precipitation extremes is evident across a broad range of event durations (from 1 to 30 days) and return intervals (1 to 20 years), particularly east of the Rocky Mountains.

There is robust evidence that human-caused warming has contributed to increases in the frequency and severity of the heaviest precipitation events across nearly 70% of the US. Paleoclimate records derived from tree-ring growth provide evidence that summer moisture has increased over the past century in parts of New England, the central-eastern US, and the northern Mississippi River valley.

The following is a more accurate summary of what U.S. data show.

There are regionally-heterogeneous changes in average and extreme precipitation. Positive trends in annual average rainfall and extreme events (defined either as the annual maximum or the number of exceedances of the 99th percentile value) are generally weak or non-existent when looking at samples exceeding 130 years in length. Significant trends can be found when beginning the sample in the 1950s although in most cases the trends weaken and become insignificant when looking at the post-1980 interval. This makes attribution to anthropogenic warming difficult.

Along the Pacific coast very few stations (1 or 2 out of 29) exhibit significant trends on any time scale in any metric and the region-wide trends are insignificant. In the Southeast region about 5 out of 24 stations exhibit positive trends in average and extreme precipitation metrics and the regional trends are likewise significant, but only on samples beginning in 1950. When the sample starts in 1873 or 1980 the trends weaken and become mostly insignificant. In the Midwest region nearly half the stations exhibit positive and significant trends in average precipitation since 1893 (23/61) and 1950 (28/61) but the trends weaken after 1980: only 6/61 locations are significant and the region-wide trend is insignificant. These positive trends reflect the dryness of the 1930's Dust Bowl era. Regional trends in max and 99th percentile exceedances are insignificant post-1893 and -1980 but the latter are positive and significant post-1950.

In the Northeast region 12 out of 27 stations exhibit positive and significant increases in average precipitation post-1888, post-1950 and post-1980 (10/27) and the regional trend is positive and significant in all three intervals. The regional number of 99th percentile exceedances has a positive trend post-1950 and post-1980 but not post-1888. The significant positive trends post-1980 are concentrated in NH but are insignificant elsewhere.

Consequently, precipitation in the U.S. exhibits considerable regional and temporal variability. Relatively more places became wetter than drier. In the Midwest and Northeast the general pattern since 1950 favors increased precipitation depending on the location, although trends since 1980 have not tended to be statistically significant.

4.2 Heatwaves

- details; NCA4 used entire 20th century while NCA5 looked at post-1960 interval

5 INADEQUATE TRACEABLE ACCOUNTS

- details

6 OVEREMPHASIS ON EXTREME SCENARIOS

To respond to the GCRA mandate to “project major trends for the subsequent 25 to 100 years,” the NCA relies on projections of future climate change based on estimates of future emissions (the so-called SSP scenarios) and/or specified levels of radiative forcing (the RCP scenarios). For the most part, NCA5 uses scenarios developed for the IPCC Assessment Reports.

In CWG Section 3.2.1 we presented a critical assessment of past and current IPCC scenario envelopes, showing that they have tended to overshoot observed emissions. In 2021, UN Climate Negotiators (COP) stopped using scenarios above 4.5. The IPCC AR6 published in 2021 stated that “The likelihood of high-emission scenarios like RCP8.5 and SSP5-8.5 is considered low in light of recent energy sector developments.” NCA5 makes the following observations about the scenarios they use:

NCA5 authors were advised to assess the full range of scenarios available. (Front Matter)

Scenarios of future emissions and land-use change are developed as plausible alternatives, but no relative likelihood is attached to them. Some recent studies, however, have argued that the highest scenario, SSP5-8.5, is no longer plausible without a reversal of current trends in the adoption of renewables and energy efficiency. (Key Message 3.3 Traceable Analysis)

Despite acknowledging the issue the NCA5 otherwise ignored the problem. A keyword search of the NCA5 of mentions of RCP/SSP scenarios finds over 50% referred to the extreme emissions scenarios RCP8.5/SSP5-8.5. Further, 10 figures only included the 8.5 scenarios: 5.2, 6.9, 7.4, 11.3, 14.6, 22.13, 22.19, 27.9, 29.13.

The problem of relying on extreme scenarios is particularly acute for sea level rise projections. The sea level rise scenarios used in the NCA5 do not relate directly to the SSP emissions scenarios, but to specified amounts of sea level rise by 2100, whereby Low relates to 0.3 m (0.98 feet), Intermediate-Low relates to 0.5 m (1.64 feet), Intermediate relates to 1.0 m (3.28 feet), Intermediate-High relates to 1.5 m (4.92 feet), and High relates to 2.0 m (6.56 feet). (Table 4 of Guide to Using this Report).

Considering only projections representing processes in whose quantification there is at least medium confidence, the IPCC AR6 assessed global mean sea level projections for 2100 to fall between 0.2 and 1.6 m (5th—95th percentile range). The corresponding range of sea level rise scenarios considered by the NCA5 is from 1.5 to 2.0 m. NCA5 neglects to include plausible lower scenarios, such as 0.2 m cited by the IPCC, which also corresponds to the average rate of sea level rise over the past century.

With regards to actual predictions of sea level rise, Chapter 9 of the NCA states: “Under a range of potential global warming levels, average sea level along US coastlines is *likely* to be between 12 and 20 inches above 2000 sea levels in 2050.” These values of sea level rise encompass the Intermediate scenario to values slightly higher than the High scenario from Table 4 << which Table 4?.

Global sea level rise projections to 2050 relative to a 2000 baseline can be evaluated with respect to the observed global sea level rise from 2000-2024, which is approximately 3.39 inches (0.28 feet). <https://www.climate.gov/news-features/understanding-climate/climate-change-global-sea-level> Hence it is inferred that NCA5 is projecting values of sea level rise between 2025 and 2050 that are 3.5 to 5.8 times the rate observed during 2000-2024.

Chapter 9 further states: “Looking toward the future, an 11 inch (28 cm) average rise along the contiguous US coastline is expected by 2050 (relative to 2020), with a *likely* range of 9-13 inches.” This analysis accounts for the observed sea level rise between 2000 and 2020.<< But they say it’s relative to 2020.

With regards to confidence levels, NCA5 Chapter 9 Traceable Accounts states: “There is *high confidence* and it is *likely* that sea levels will rise about 11 inches (likely range of about 9–13 inches) between 2020 and 2050” Neither the statement nor the context in the paragraph distinguishes as to whether this refers to global sea level rise, or US average sea level rise, although it is inferred to refer to global sea level rise.

In summary, the NCA5 presents future sea level rise scenarios that are not directly relatable either to SSP/RCP emissions scenarios or global warming levels. The NCA5 scenarios include two scenarios that are higher than the 95th percentile for the extreme emissions scenario RCP8.5 and include hypothesized ice sheet processes for which there is low confidence. Projections to 2050 require rates of sea level rise from 2025 to 2050 that are more than three times the rate observed during 2020-2024. Further, the NCA5 ascribes *high confidence* to these sea level rise projections.

The inclusion, and even the focus, on implausible extreme emissions scenarios supports projections of alarming impacts that are very unlikely to be driven by anthropogenic warming.

7 BIASED SELECTION OF REFERENCES

-details

8 SUMMARY: EVALUATION OF THE NCA5

8.1 Pertinent aspects when evaluating in light of statutory requirements

- not our remit to make a ruling but here are aspects to consider in light of statutory requirements

8.2 Evaluation from the perspective of expert users of the report

- we have deep knowledge of the topics surveyed by the NCA5 authors
- we do not have confidence that the report was balanced and comprehensive
- we can point to many specific instances in which the report did not exhibit an appropriate level of quality or integrity as a scientific document
- we have reason to believe the whole process, from author selection to handling of expert reviews, was biased towards reinforcing foregone conclusions and alarmist messaging

8.3 Evaluation from the perspective of citizens interested in good policymaking

- Public concerns about climate change are valid, as are concerns about cost of living, economic growth, employment, etc.
- We share the general concern that elected officials and those who serve them have the best information available when making important decisions around energy and climate policy
- NCA5 was a missed opportunity: it could have been a valuable input to that process but it did not turn out that way
- consequently its usage is unlikely to lead to better decisions and would more likely increase the error rate in policy formation and we recommend it not be used for policymaking purposes.

APPENDIX 1: Seth's letter on statutory requirements for NCA5

APPENDIX 2: Analysis of 141 U.S. Longterm Daily Precipitation Records.

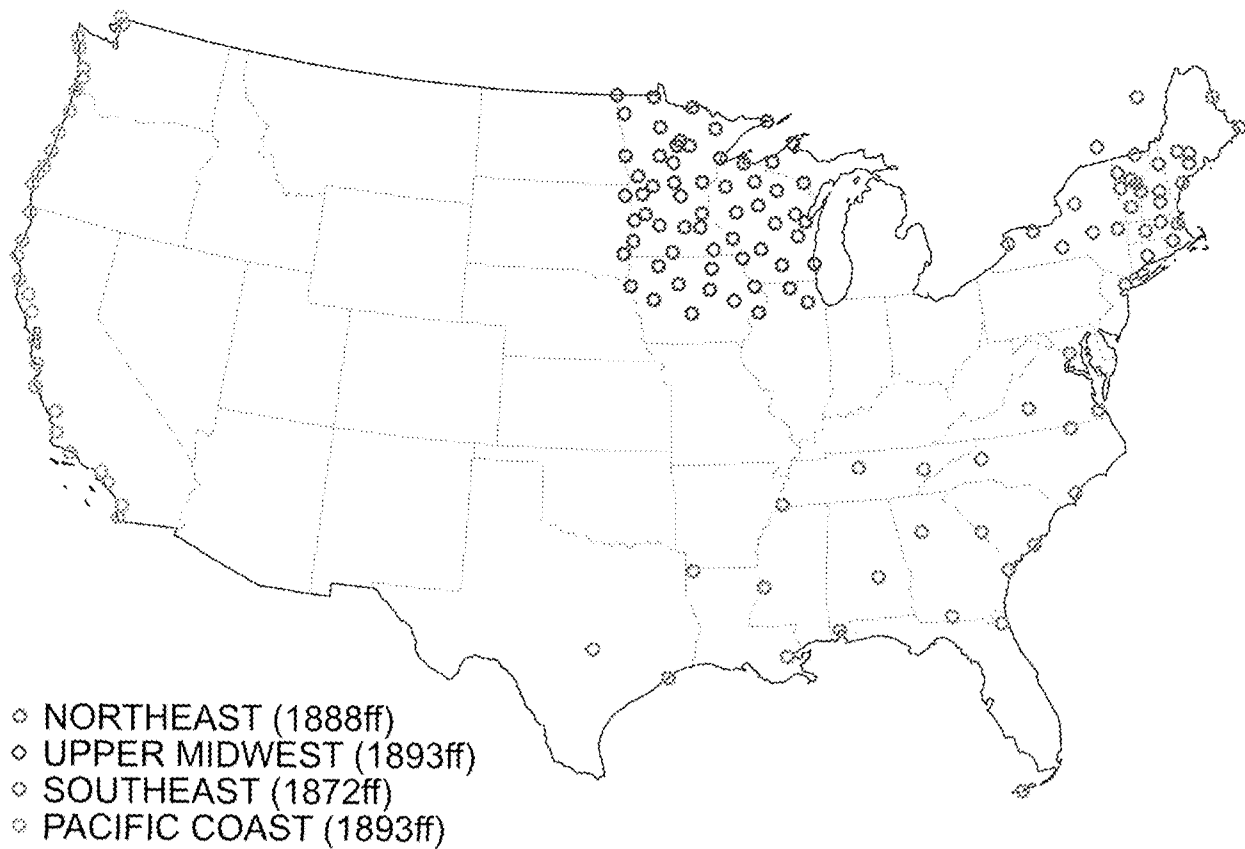


Figure. Stations used in the following analyses.

Table codes: (-) neg insignificant, -- neg significant, (+) pos insignificant, ++ pos significant.

Column 1: Measure

Column 2: Number of stations in that region

Column 3: Count of stations exhibiting a significant positive trend

Column 3: Count of stations exhibiting a significant negative trend

Column 5: Characteristic of region-wide trend

PACIFIC COAST

Since 1893:

	No. stns	+ trends	- trends	region
1-day average	29	0	1	(-)
2-day average	29	0	1	(-)
Avg on non-zero days	29	0	9	--
Variability	29	1	0	(+)
Annual max	29	2	1	(+)

Number of 99 th pct exceedances	29	1	0	(-)
--	----	---	---	-----

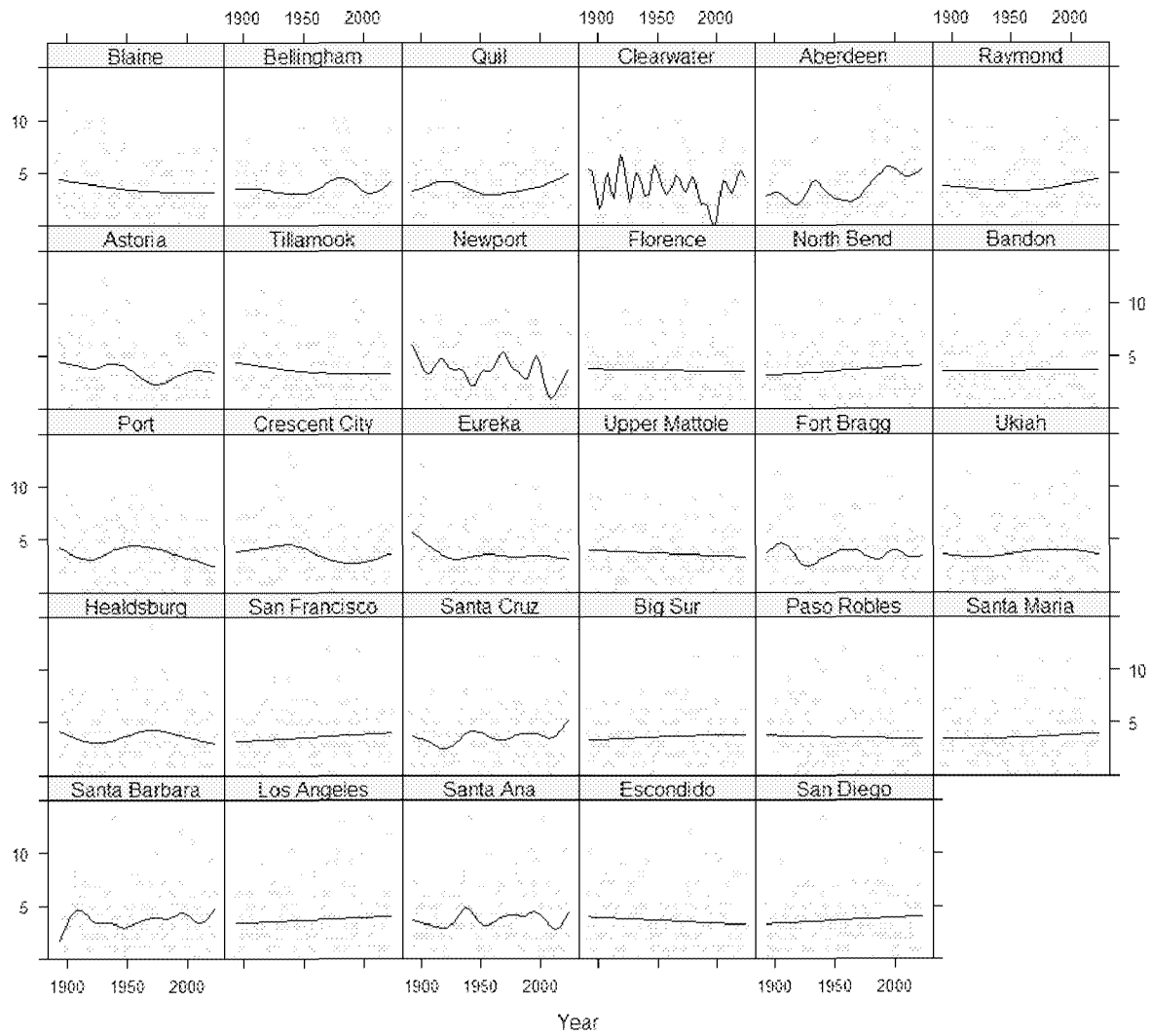
Since 1950:

	No. stns	+ trends	- trends	region
1-day average	29	0	1	(-)
2-day average	29	0	1	(-)
Avg on non-zero days	29	0	4	(-)
Variability	29	2	3	(-)
Annual max	29	6	3	(-)
Number of 99 th pct exceedances	29	2	1	(-)

Since 1980:

	No. stns	+ trends	- trends	region
1-day average	29	0	0	(-)
2-day average	29	0	0	(-)
Avg on non-zero days	29	0	1	(-)
Variability	29	0	0	(-)
Annual max	29	2	1	(-)
Number of 99 th pct exceedances	29	0	0	(+)

Annual No. 99th Percentile Exceedances PC 1893-2024



SOUTHEAST

Since 1873:

	No. stns	+ trends	- trends	region
1-day average	24	1	1	(+)
2-day average	24	1	1	(+)
Avg on non-zero days	24	7	2	(+)
Variability	24	1	0	(+)
Annual max	24	2	0	(+)
Number of 99 th pct exceedances	24	5	0	(+)

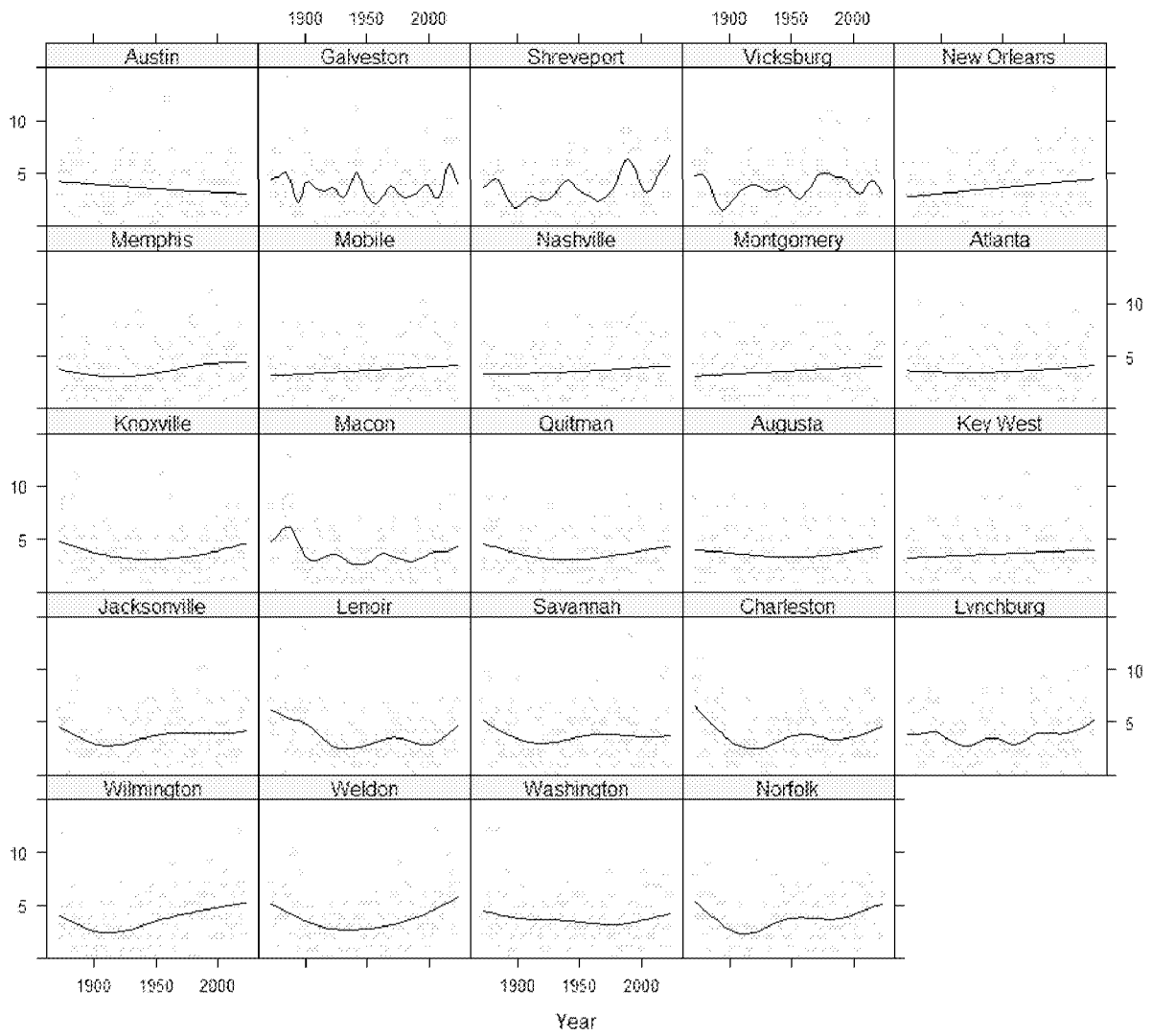
Since 1950:

	No. stns	+ trends	- trends	region
1-day average	24	5	0	++
2-day average	24	5	0	++
Avg on non-zero days	24	5	1	++
Variability	24	6	0	++
Annual max	24	4	0	++
Number of 99 th pct exceedances	24	4	0	(+)

Since 1980:

	No. stns	+ trends	- trends	region
1-day average	24	5	0	(+)
2-day average	24	5	0	(+)
Avg on non-zero days	24	5	1	(+)
Variability	24	3	0	(+)
Annual max	24	4	0	(+)
Number of 99 th pct exceedances	24	4	0	(+)

Annual No. 99th Percentile Exceedances SE 1873-2024



MIDWEST

Since 1893:

	No. stns	+ trends	- trends	region
1-day average	61	23	0	++
2-day average	61	23	0	++
Avg on non-zero days	61	2	12	(+)
Variability	61	12	0	++
Annual max	61	9	0	(+)
Number of 99 th pct exceedances	61	10	0	(+)

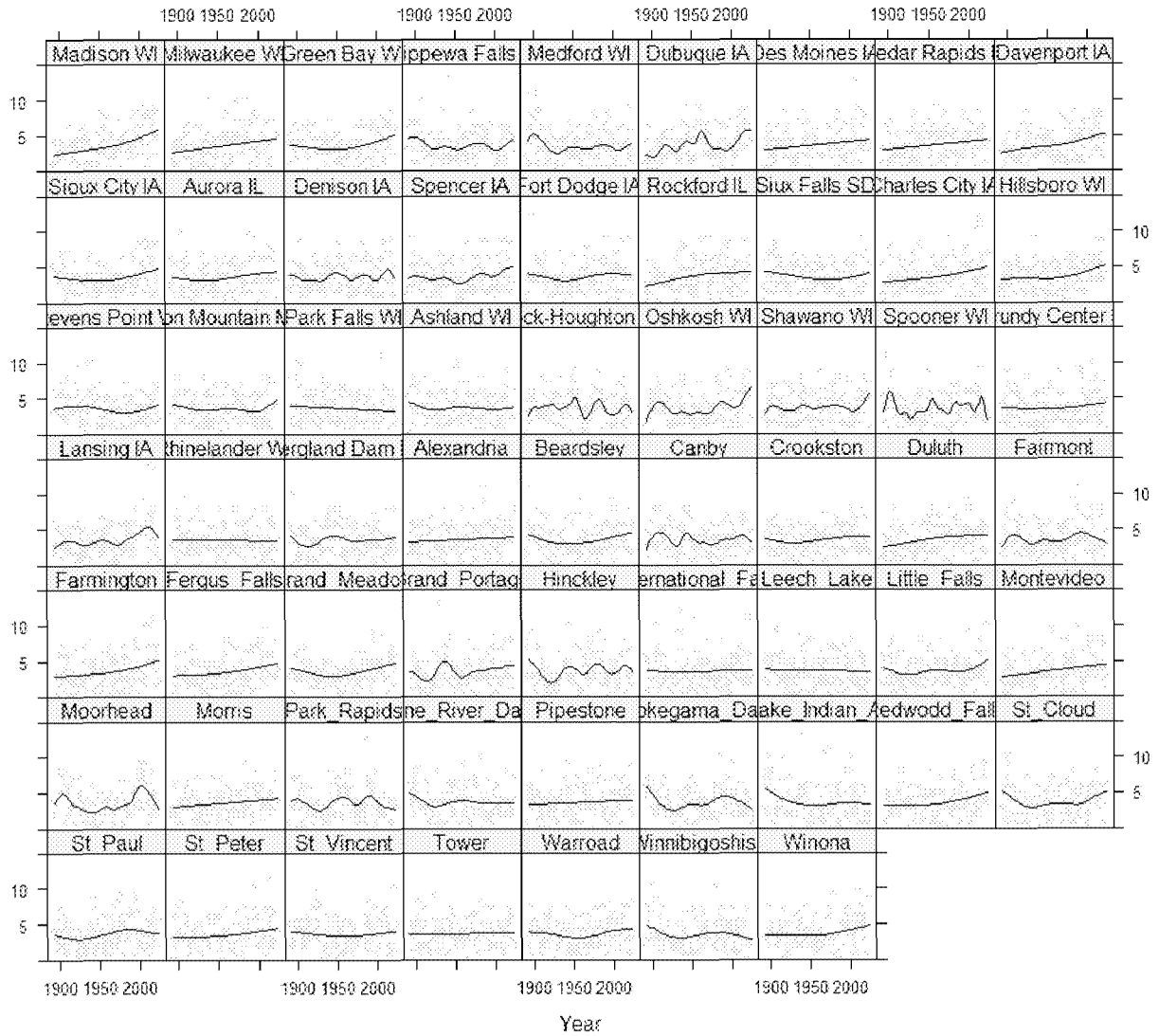
Since 1950:

	No. stns	+ trends	- trends	region
1-day average	61	28	2	++
2-day average	61	28	2	++
Avg on non-zero days	61	11	1	++
Variability	61	16	0	(+)
Annual max	61	8	0	(+)
Number of 99 th pct exceedances	61	19	0	++

Since 1980:

	No. stns	+ trends	- trends	region
1-day average	61	6	1	(+)
2-day average	61	6	1	(+)
Avg on non-zero days	61	8	2	(+)
Variability	61	5	1	(+)
Annual max	61	0	1	(+)
Number of 99 th pct exceedances	61	5	3	(-)

Annual No. 99th Percentile Exceedances MW 1893-2024



NORTHEAST

Since 1888:

	No. stns	+ trends	- trends	region
1-day average	27	12	0	++
2-day average	27	12	0	++
Avg on non-zero days	27	7	1	(+)
Variability	27	4	0	(+)
Annual max	27	3	0	(-)
Number of 99 th pct exceedances	27	5	0	(+)

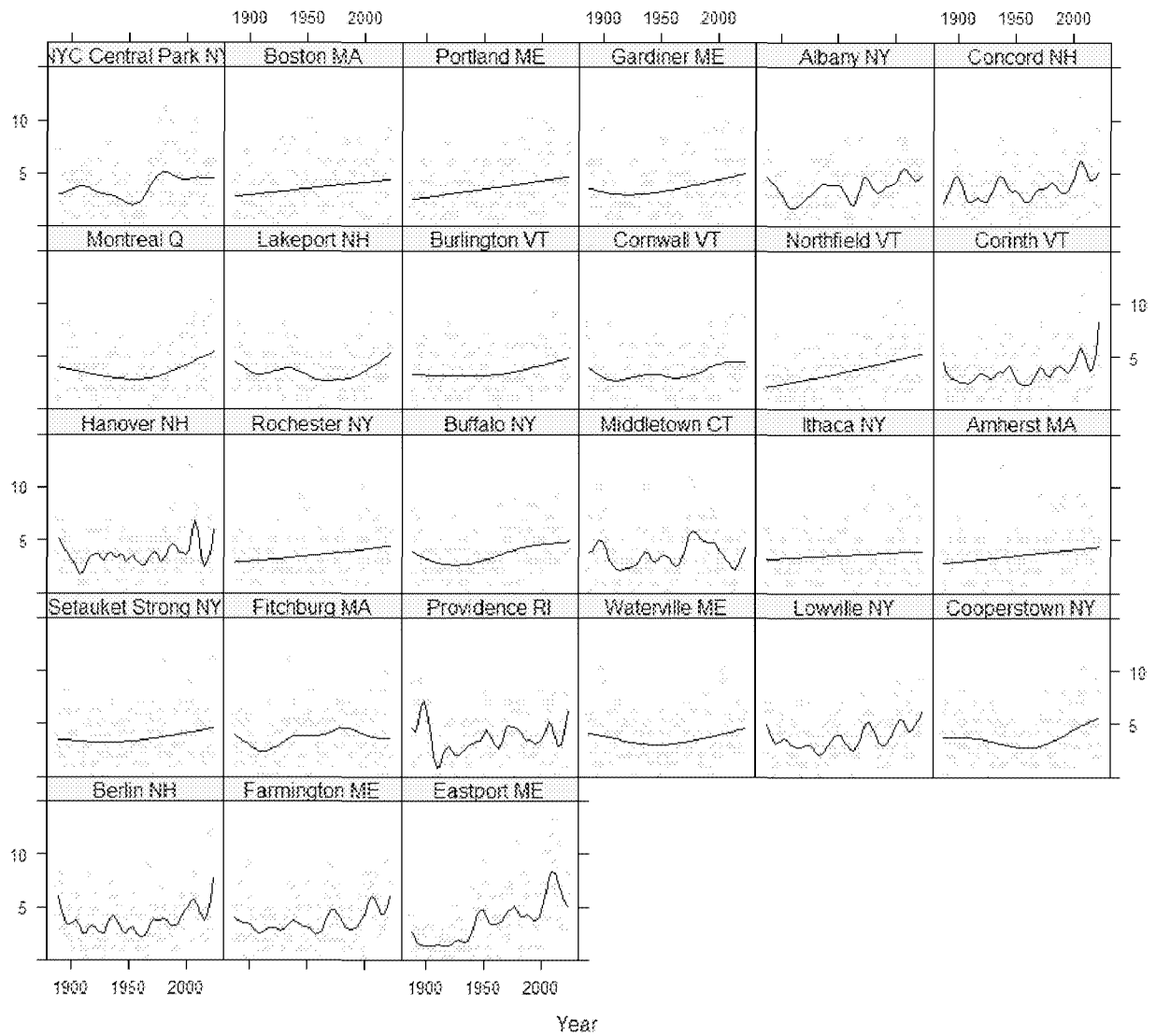
Since 1950:

	No. stns	+ trends	- trends	region
1-day average	27	12	0	++
2-day average	27	12	0	++
Avg on non-zero days	27	7	1	(+)
Variability	27	4	0	(+)
Annual max	27	3	0	(-)
Number of 99 th pct exceedances	27	5	0	++

Since 1980:

	No. stns	+ trends	- trends	region
1-day average	27	10	1	++
2-day average	27	10	1	++
Avg on non-zero days	27	6	0	(+)
Variability	27	2	0	(+)
Annual max	27	1	0	(+)
Number of 99 th pct exceedances	27	1	1	++

Annual No. 99th Percentile Exceedances NE 1888-2024



From: Ross McKittrick <ross.mckittrick@gmail.com>
Sent: Wednesday, August 13, 2025 10:12 AM
To: N H Lewis
Cc: Judith Curry; John Christy; Roy Spencer; Steven Koonin
Subject: Re: Carbon Brief factcheck - your study has been cited in new US DoE 'critical review'

Thanks Nic. Congrats on the ACP paper. We'll update the citation in the revision.
Cheers,
Ross

On Wed, Aug 13, 2025 at 4:20 AM N H Lewis <nhlewis@btinternet.com> wrote:

Dear All

You cited in chapter 4 of your DoE report the preprint of my Comment on Sherwood & Forest's 2024 ACP piece on climate sensitivity. I am pleased to say that the final version of my Comment has today been published in ACP, [here](#). Thanks to a detailed public comment by Steven Sherwood on my manuscript (which was treated as obviating the need for a second anonymous peer review: see [here](#)), I was able to make my comment considerably more extensive. Steven's understanding both of Lewis (2022) and of statistical aspects of Sherwood et al (2020) appears limited.

FYI, I submitted very favourable comments to The Associated Press on your DoE report. I have not responded to the Carbon Brief email. As you may be aware, although it is called a 'Fact check', the only ratings allowed for points being checked are False or Misleading – hardly unbiased!

All the best,

Nic

From: N H Lewis [mailto:nhlewis@btinternet.com]
Sent: 06 August 2025 15:43
To: 'Judith Curry'; 'Ross McKittrick'; 'John Christy'; 'Roy Spencer'; 'Steven Koonin'
Cc: 'nhlewis@btinternet.com'
Subject: FW: Carbon Brief factcheck - your study has been cited in new US DoE 'critical review'

Dear All

I expect that you are all aware of Carbon Brief's activities in relation to your recent DOE Climate Working Group review report, but just in case you aren't here is a copy of their recent email, presumably sent to all climate scientists with papers cited in your report.

I've now had a similar email from Michael Phillis at The Associated Press (copy attached). He and their Seth Borenstein have decided to ask a number of questions of the authors of every science-oriented reference in both the actual EPA proposal and the Department of Energy Climate Working Group's review report about the EPA's proposed rescinding the 2009 Endangerment Finding.

All the best,

Nic

From: Leo Hickman [mailto:leo.hickman@carbonbrief.org]
Sent: 05 August 2025 13:23
To: Leo Hickman
Subject: Carbon Brief factcheck - your study has been cited in new US DoE 'critical review'

Hello,

I'm contacting you because we have noticed that at least one of your studies has been cited in a new report published this week by the US Dept of Energy titled, "A Critical Review of Impacts of Greenhouse Gas Emissions on the U.S. Climate."

A number of scientists cited in the report have already publicly highlighted that their findings have been falsely or misleadingly characterised. It seems that the report is intended to be used as scientific justification by the Trump administration in its efforts to revoke the US Environmental Protection Agency's "endangerment finding" on greenhouse gases.

Carbon Brief is now seeking your help to assess whether your own study, or indeed your area(s) of expertise more widely, have been mischaracterised in the report. This is part of a wider 'crowdsourced' fact-checking effort we are now convening to draw on inputs from experts in their respective fields.

I have attached a PDF with some instructions on how you can participate with your own insights and reflections, should you wish. (The instructions include ways to do this anonymously and securely, if that is your preference.)

Additionally, if you know of a colleague or co-author who might wish to participate, please feel free to forward this email to them.

Our deadline for submissions is Monday 11 August 2025 - 0900 GMT.

Many thanks in advance.

Best wishes, Leo

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Leo Hickman

Editor, Carbon Brief

Phone: + 44 (0) 7731 403979

Social: Twitter; BlueSky; LinkedIn

Web: www.carbonbrief.org

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From: Ross McKittrick <ross.mckittrick@gmail.com>
Sent: Friday, May 9, 2025 4:15 PM
To: Steven Koonin
Cc: Judith Curry; Roy Spencer; John Christy; Travis Fisher
Subject: Re: checking in and going forward

I was also thinking we need an About the Authors section at the end.

On Fri, May 9, 2025 at 4:10 PM Steven Koonin <steven.koonin@gmail.com> wrote:

Lots of email traffic in the past few hours – it'll take me a day or so to absorb and react.

My immediate plans are to focus on the latest drafts of Ch 5-7. I've got time this tomorrow and a flight EWR/SFO on Sunday to tend to that. I'll look at the front matter and recent (relatively minor) revisions of the other chapters will come after that.

I think I could be through it all by Wednesday, May 14. Too late?

SEK

PS I think an appendix with 1-paragraph bios (and thumbnail photo?) would be useful. Credentials will matter to most non-expert readers. Thoughts?

From: Steven Koonin <steven.koonin@gmail.com>
Sent: Friday, May 9, 2025 4:10 PM
To: 'Judith Curry'; 'Roy Spencer'
Cc: 'Ross McKittrick'; 'John Christy'; 'Travis Fisher'
Subject: checking in and going forward

Lots of email traffic in the past few hours – it'll take me a day or so to absorb and react.

My immediate plans are to focus on the latest drafts of Ch 5-7. I've got time this tomorrow and a flight EWR/SFO on Sunday to tend to that. I'll look at the front matter and recent (relatively minor) revisions of the other chapters will come after that.

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SEK

PS I think an appendix with 1-paragraph bios (and thumbnail photo?) would be useful. Credentials will matter to most non-expert readers. Thoughts?

From: Judith Curry <curry.judith@gmail.com>
Sent: Friday, June 6, 2025 4:17 PM
To: John Christy
Cc: Ross McKittrick; Steven Koonin; Travis Fisher; Josh Loucks; Roy W. Spencer; seth.cohen@hq.doe.gov
Subject: Re: correct version sea level rise
Attachments: NCA SLR 2.docx

ugh, here is the correct attachment

On Fri, Jun 6, 2025 at 1:06 PM John Christy <climateman60@gmail.com> wrote:
Was there an attachment?

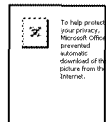
On Fri, Jun 6, 2025 at 3:03 PM Judith Curry <curry.judith@gmail.com> wrote:
disregard previous email, this version is correct

On Fri, Jun 6, 2025 at 12:46 PM Judith Curry <curry.judith@gmail.com> wrote:
My text on sea level rise is attached. SK gave a preview of how crazy this is in his previous graph for The Battery. I have worked to simplify this and shorten, but it may need more.

ps recent files from my old laptop are non-recoverable, so I need to recreate hurricanes and 8.5 scenarios



Judith Curry, President
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<http://www.cfanclimate.net>



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<http://www.cfanclimate.net>

Sea level rise projections

The NCA5 states: “Global average sea levels over the past decade were also higher than in the preindustrial period by between 7 and 9.5 inches, with more than half of this rise occurring since 1980.” The issue with the NCA5 is not related to observed levels of sea level rise, but rather to their projections to 2050 and 2100.

The sea level rise scenarios used in the NCA5 do not relate directly to the SSP emissions scenarios, but to specified amounts of sea level rise by 2100, whereby Low relates to 0.3 m (0.98 feet), Intermediate-Low relates to 0.5 m (1.64 feet), Intermediate relates to 1.0 m (3.28 feet), Intermediate-High relates to 1.5 m (4.92 feet), and High relates to 2.0 m (6.56 feet). (Table 4 of Guide to Using this Report).

Table 4. Descriptive Terms for Common Sea Level Rise Scenarios Used in NCA5

Future global mean sea level rise and sea level rise along United States coastline are shown for five scenarios in feet (and meters), relative to a 2000 baseline. The US values shown in the right half of the table are averaged across the US coastal regions, including the contiguous US, Alaska, Hawai'i and the US-Affiliated Pacific Islands, and the US Caribbean. The national values shown in the table differ substantially from regional values. For example, sea level rise is higher in the Gulf Coast and lower or even negative in some parts of Alaska. In the next 30 years (2030–2050), sea level along the contiguous US coasts is expected to rise 0.92 feet (0.28 m), the same amount of sea level rise observed over the last 100 years (1920–2020). See Chapter 9 for regional sea level information. Adapted from Sweet et al. 2022.”

Sea Level Rise Scenario Descriptor	Global Mean Sea Level			United States		
Year	2050	2100	2150	2050	2100	2150
Low	0.49 (0.15)	0.98 (0.3)	1.31 (0.4)	0.59 (0.18)	0.98 (0.3)	1.64 (0.5)
Intermediate-Low	0.66 (0.20)	1.64 (0.5)	2.62 (0.8)	0.75 (0.23)	1.64 (0.5)	2.95 (0.9)
Intermediate	0.92 (0.28)	3.28 (1.0)	6.23 (1.9)	0.89 (0.27)	3.28 (1.0)	6.89 (2.1)
Intermediate-High	1.21 (0.37)	4.92 (1.5)	8.86 (2.7)	1.12 (0.34)	4.92 (1.5)	8.86 (2.7)
High	1.41 (0.43)	6.56 (2.0)	12.14 (3.7)	1.38 (0.42)	6.56 (2.0)	12.46 (3.8)

Considering only projections representing processes in whose quantification there is at least medium confidence, the IPCC AR6 assessed global mean sea level projections for 2100 to fall between 0.2 and 1.6 m for the 5th–95th percentile range, for all scenarios ranging from RCP2.6 to RCP8.5. The IPCC AR6 cites values as high as 2.4 m at the upper end of the 95th percentile range for RCP8.5, if estimates include the hypothesized Marine Ice Cliff Instability (low confidence).

The range of sea level rise scenarios considered by the NCA5 includes Intermediate-High and High values associated with the implausible extreme emissions scenario RCP8.5 and processes in which there is low confidence in understanding. And neglects to include plausible lower scenarios, such as 0.2 m cited by the IPCC, that corresponds to the average rate of sea level rise over the past century.

Chapter 9 of the NCA states: “Under a range of potential global warming levels, average sea level along US coastlines is *likely* to be between 12 and 20 inches above 2000 sea levels in 2050 (Figure 9.2).” These values of sea level rise encompass the Intermediate scenario to values slightly higher than the High scenario.

Global sea level rise projections to 2050 relative to a 2000 baseline can be evaluated with respect to the observed global sea level rise from 2000–2024, which is approximately 3.39 inches (0.28 feet).

<https://www.climate.gov/news-features/understanding-climate/climate-change-global-sea-level>

Hence it is inferred that NCA5 is projecting values of sea level rise between 2025 and 2050 that are 3.5 to 5.8 times the rate observed during 2000-2024.

Chapter 9 further states: “Looking toward the future, an 11 inch 28 cm average rise along the contiguous US coastline is expected by 2050 (relative to 2020), with a *likely* range of 9-13 inches.” This analysis accounts for the observed sea level rise between 2000 and 2020.

With regards to confidence levels, NCA5 Chapter 9 Traceable Accounts states: “There is *high confidence* and it is *likely* that sea levels will rise about 11 inches (likely range of about 9–13 inches) between 2020 and 2050” Neither the statement nor the context in the paragraph does not distinguish as to whether this refers to global sea level rise, or US average sea level rise, although it is inferred to refer to global sea level rise.

In summary, the NCA5 presents future sea level rise scenarios that are not directly relatable either to SSP/RCP emissions scenarios or global warming levels. The NCA5 scenarios include two scenarios that are higher than the 95th percentile for the extreme emissions scenario RCP8.5 and include hypothesized ice sheet processes for which there is low confidence. Projections to 2050 require rates of sea level rise during 2025 through 2050 that are more than three times the rate observed during 2020-2024. Further, the NCA5 ascribes high confidence to these sea level rise projections.

From: John Christy <climateman60@gmail.com>
Sent: Friday, June 6, 2025 4:06 PM
To: Judith Curry
Cc: Ross McKittrick; Steven Koonin; Travis Fisher; Josh Loucks; Roy W. Spencer; seth.cohen@hq.doe.gov
Subject: Re: correct version sea level rise

Was there an attachment?

On Fri, Jun 6, 2025 at 3:03 PM Judith Curry <curry.judith@gmail.com> wrote:
disregard previous email, this version is correct

On Fri, Jun 6, 2025 at 12:46 PM Judith Curry <curry.judith@gmail.com> wrote:
My text on sea level rise is attached. SK gave a preview of how crazy this is in his previous graph for The Battery. I have worked to simplify this and shorten, but it may need more.

ps recent files from my old laptop are non-recoverable, so I need to recreate hurricanes and 8.5 scenarios



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From: Ross McKittrick [ross.mckittrick@gmail.com]
Sent: 6/18/2025 4:07:06 PM
To: Judith Curry [curry.judith@gmail.com]; Roy W. Spencer [roywspencer@hotmail.com]; John Christy [climateman60@gmail.com]; Steven Koonin [steven.koonin@gmail.com]; Travis Fisher [travis.scott.fisher@gmail.com]; Josh Loucks [loucksj14@gmail.com]; Cohen, Seth [seth.cohen@hq.doe.gov]
Subject: NCA5 report June 18 edition
Attachments: 01.NCA5.Review.June18 [SEK][JCurry][RMcK].docx

In this edition I have accepted the edits up to this point except where they call for deletion of large sections or (as in section 8) a major rewrite.

All footnotes are either incorporated into the text or converted to a reference list which is now at the end.

In some of the places where Steve or Judy had asked for clarification I've rephrased the text.

Etc.

Over to Roy.

Review of the Fifth National Climate Assessment

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EXECUTIVE SUMMARY

This report critically evaluates the Fifth National Climate Assessment (NCA5), finding it an inadequate basis for climate and energy policies. A detailed review of the foundational chapters on climate science raises several key concerns:

Scientific Integrity

- An advocacy tone, particularly in the Overview chapter, inconsistent with scientific objectivity
- An endemic overconfidence when stating conclusions, including inflated certainty levels and overstatement of findings from underlying sources

Flawed methodology

- Use of *ad hoc* time scales for trend analyses in areas such as precipitation and heatwaves
- An overemphasis on extreme scenarios for future emissions
- Inadequate traceable accounts to support key conclusions

Deficient Review Process

- A review by the National Academy of Sciences, Engineering, and Medicine (NASEM) failed to challenge some fundamental flaws in NCA5
- The NCA5 authors failed to adopt some improvements recommended by NASEM

The report shows NCA5 to be a biased and incomplete picture of climate science that skews toward excessive climate risk. Consequently, NCA5 should not be used as basis for climate and energy policies.

1 INTRODUCTION

1.1 About this Report

This report responds to a request from OSTP Director Michael Kratsios (reproduced in Appendix 1) that we assess the suitability of the Fifth National Climate Assessment (NCA5 2023) for informing climate and energy policies.

To conduct this assessment we reviewed NCA5 itself, the National Academies (NASEM) review of the Third Order Draft, and the USGCRP responses to that review. We have drawn upon our long experience working on advisory reports, including for the NASEM, the IPCC and other organizations, as writers, reviewers and study leaders.

We find that NCA5 should not be relied on for policy making as it is an incomplete and misleading picture of our understanding of the changing climate and the risks it poses to the nation. NCA5 was selective and incomplete in its survey of climate science as of its publication in 2023 and has become even more so in the years since. We have reviewed many key scientific developments in a separate report to Energy Secretary Wright (Climate Working Group 2025, herein denoted “CWG25”). The overall effect of the biases and omissions of NCA5 is an excessively dire picture of climate risk.

To support our finding, the following sections of this chapter provide some background on the National Climate Assessments and the standards by which we have assessed NCA5. Chapters 2 through 6 detail important ways in which NCA5 fails to meet those standards. Chapter 7 then follows with an assessment of the NASEM review. Finally, Chapter 8 summarizes our evaluation of NCA5.

1.2 About the National Climate Assessments

The U.S. Global Change Research Program (USGCRP) was established by Presidential Initiative in 1989 and mandated by Congress in the Global Change Research Act (GCRA) of 1990 to develop and coordinate “a comprehensive and integrated United States research program which will assist the Nation and the world to understand, assess, predict, and respond to human-induced and natural processes of global change.”

The National Climate Assessment (NCA) Reports evolved from the GCRA requirement to

Prepare and submit to the President and the Congress an assessment which (1) integrates, evaluates, and interprets the findings of the Program and discusses the scientific uncertainties associated with such findings; (2) analyzes the effects of global change on the natural environment, agriculture, energy production and use, land and water resources, transportation, human health and welfare, human social systems, and biological diversity; and (3) analyzes current trends in global change, both human-induced and natural, and projects major trends for the subsequent 25 to 100 years.

The five NCA Reports to date have interpreted this mandate in different ways:

- NCA1 (2000) was a multidisciplinary effort to study and portray in regional detail the potential effects of human-induced global warming on the United States.
- NCA2 (2009) was a relatively short report that not only focused on the potential consequences of climate change but also sought to identify potential adaptation measures and identify the highest priorities for future research.

- NCA3 (2014) was an expanded effort that continued along the lines of NCA2, and was distinguished by a comprehensive review process, including a review by the National Academy of Sciences. NCA3 introduced a traceability analysis for each key finding, including a description of uncertainties.
- NCA4 (2017/2018) was a further expanded effort published in two volumes: I Climate Science Special Report, and II Impacts, Risk, and Adaptation in the United States. This was the first NCA report to devote significant effort to assessing climate science.
- NCA5 (2023) returned to a single volume format, reducing discussion of climate science to a cursory two chapters, with continuing with a focus on regional and sectoral impacts of climate change. NCA5 expanded its remit to topics that are arguably outside the purview of the USGCRP, focusing on “Climate Action” and policy recommendations with a social justice emphasis. NCA5’s self-description is reproduced as Appendix II.

These successive interpretations of the NCA are poorly aligned with the GCRA’s statutory requirements. Only NCA4 gives serious consideration to climate science, which receives the great majority of USGCRP funding, and even then misrepresents some important points (Section 1.4 below offers an example). Natural climate variability is essentially dismissed as unimportant in NCA4 and barely mentioned in NCA5 in most contexts, despite the mandate to include both human-caused and natural climate change. Most significantly, NCA5 has redirected the focus away from climate science and even the hazard elements of impacts, towards evaluation of societal vulnerabilities and advocacy for particular policy options, especially wind and solar power. The cover image for the NCA5 Report is the installation of a solar panel.

1.3 Standards for Assessing NCA Products

In Appendix 2 we include a letter of guidance from the Office of General Counsel, U.S. Department of Energy, summarizing the statutory requirements governing USGCRP work products in general and NCA products in particular.

We can summarize the standards applicable to the NCA as follows:

- details

Beyond the statutory requirements we draw attention to two other pertinent standards. President Trump’s executive order of May 23, 2025, “Restoring Gold Standard Science” enumerates some of the characteristics of good science:

- i. reproducible;
- ii. transparent;
- iii. communicative of error and uncertainty;
- iv. collaborative and interdisciplinary;
- v. skeptical of its findings and assumptions;
- vi. structured for falsifiability of hypotheses;
- vii. subject to unbiased peer review;
- viii. accepting of negative results as positive outcomes; and
- ix. without conflicts of interest.

Although these should be self-evident to those trained in science, it is surprising that some scientists have found them controversial (Dellawalla et al. 2025).

There are other desiderata for scientific reports that will be highly influential on climate policymaking. Among them are statements about the strength of climate knowledge. The IPCC's approach is based on judgment of the available evidence and agreement among experts. More sophisticated knowledge characterizations for risk management include (Arven 2017):

- The degree to which the assumptions made are reasonable/realistic based on background knowledge
- The degree to which data/information exists and are reliable and relevant
- The degree to which there is disagreement among experts (including those from different environments or academic fields)
- The degree to which the phenomena involved are understood and accurate models exist
- The degree to which the knowledge has been thoroughly examined with respect to unknown knowns

Good climate and energy policies balance the risks and benefits of a changing climate against the world's growing demand for reliable and affordable energy. To strike that balance, policymakers must understand at least two complex and nuanced topics: the certainties and uncertainties of climate science and the technoeconomic realities of energy systems. Experts in those subjects have a responsibility to communicate their understanding to non-experts clearly, completely, and without bias.

Expertise in energy systems resides largely in the private sector, where it is essential to providing the reliable and affordable energy services that are the lifeblood of society. Understanding is therefore continually refined and tested by the discipline of the marketplace. In contrast, climate science expertise is found largely in the non-profit realm of universities and government laboratories and so has a more academic character.

In recent decades, climate science has engendered passion and emotion. Indeed, some younger climate scientists have gone into the field to "save the planet." Further, the field of climate science has been politicized by NetZero mandates. It is then not surprising that objectivity can suffer when climate scientists communicate their understanding to non-experts. This lack of objectivity usurps the public's right to make informed choices and undermines their confidence in the scientific enterprise.

In 1980, then-President of the National Academy of Sciences Philip Handler identified the problem in an editorial (Handler 1980) that resonates eerily four decades later:

Difficulty arises in the scientific community from confusion of the role of scientist *qua* scientist with that of scientist as citizen, confusion of the ethical code of the scientist with the obligation of the citizen, blurring the distinction between intrinsically scientific and intrinsically political questions. When scientists fail to recognize these boundaries, their own ideological beliefs, usually unspoken, easily becloud seemingly scientific debate.

1.4 When Peer Review Fails

Peer review of reports like IPCC and NCA products is not a silver bullet that guarantees quality. The peer review process for these reports differs in some important respects from traditional peer review

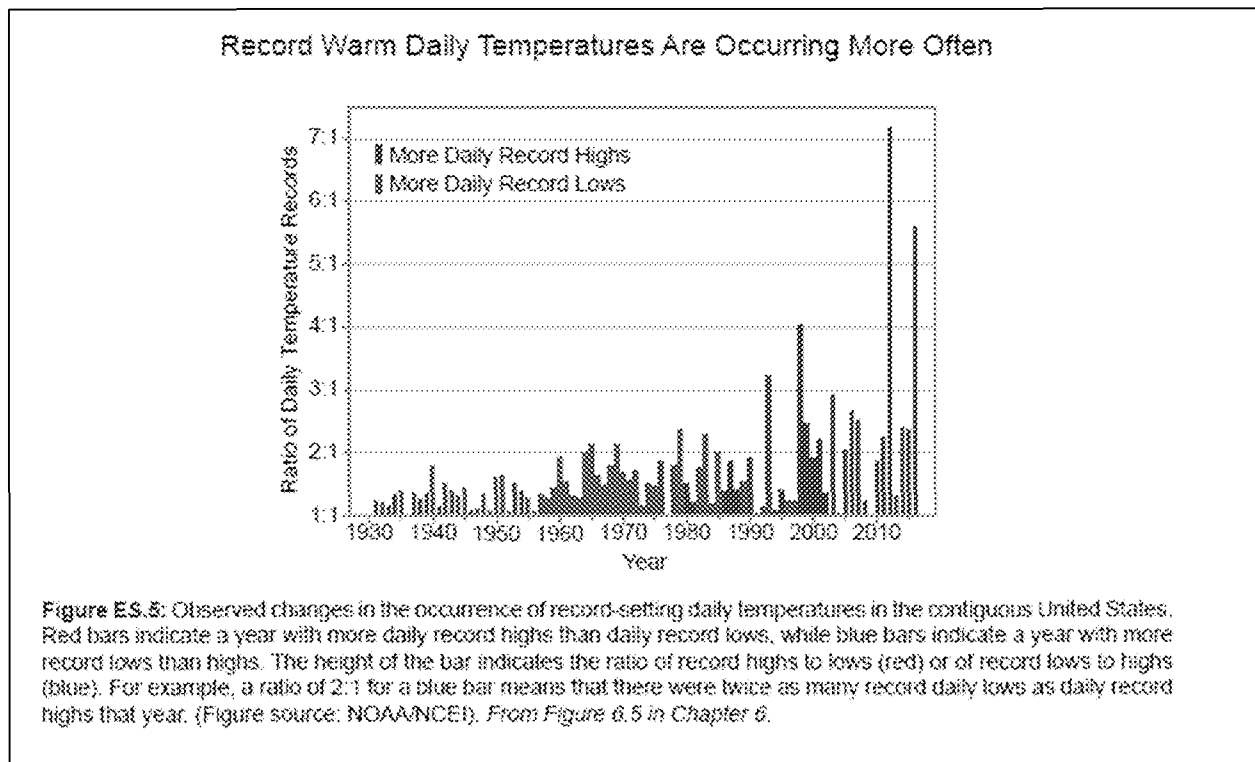
in academic journals. First, during the open review phases of early NCA drafts reviewers are volunteers who self-select what parts of the report to read, whereas the editors of academic journals recruit reviewers with relevant expertise and assign them to specific papers. As a result, there is no guarantee at that stage that any particular section of an NCA report was reviewed by anyone, let alone by someone with a perspective that differs from the authors. In fact, many potential reviewers have given up over the years because their input has systematically been ignored. The introduction of a NASEM review stage is at best a partial remedy for this. However, NCA authors have near complete authority whether to accept or reject review comments. By contrast, the Editor of an academic journal mandates the author to respond, and the reviewer and Editor assess its adequacy. Finally, the work of an NCA chapter author team is guaranteed to be published, whereas academic journals routinely reject papers that do not pass review.

These points are important to bear in mind because some readers might dismiss any criticism of NCA products out of hand on the grounds that they were “peer reviewed”. But the test of a report is whether its contents are a valid representation of the available evidence. Here we give an example in which NCA4 gave prominence to a figure that completely misrepresented the underlying data and which evaded peer review to do so. Further details can be found in Koonin (2024).

As shown in CWG25 Section 6.3 the number of heat extremes in the U.S. peaked in the 1930s and has declined ever since. Considering cold and hot extremes together the U.S. the U.S. climate has become more moderate over time. NCA4’s Part I says (prominently and with *Very High Confidence*) on Page 19 of the Executive Summary:

There have been marked changes in temperature extremes across the contiguous United States. The number of high temperature records set in the past two decades far exceeds the number of low temperature records.

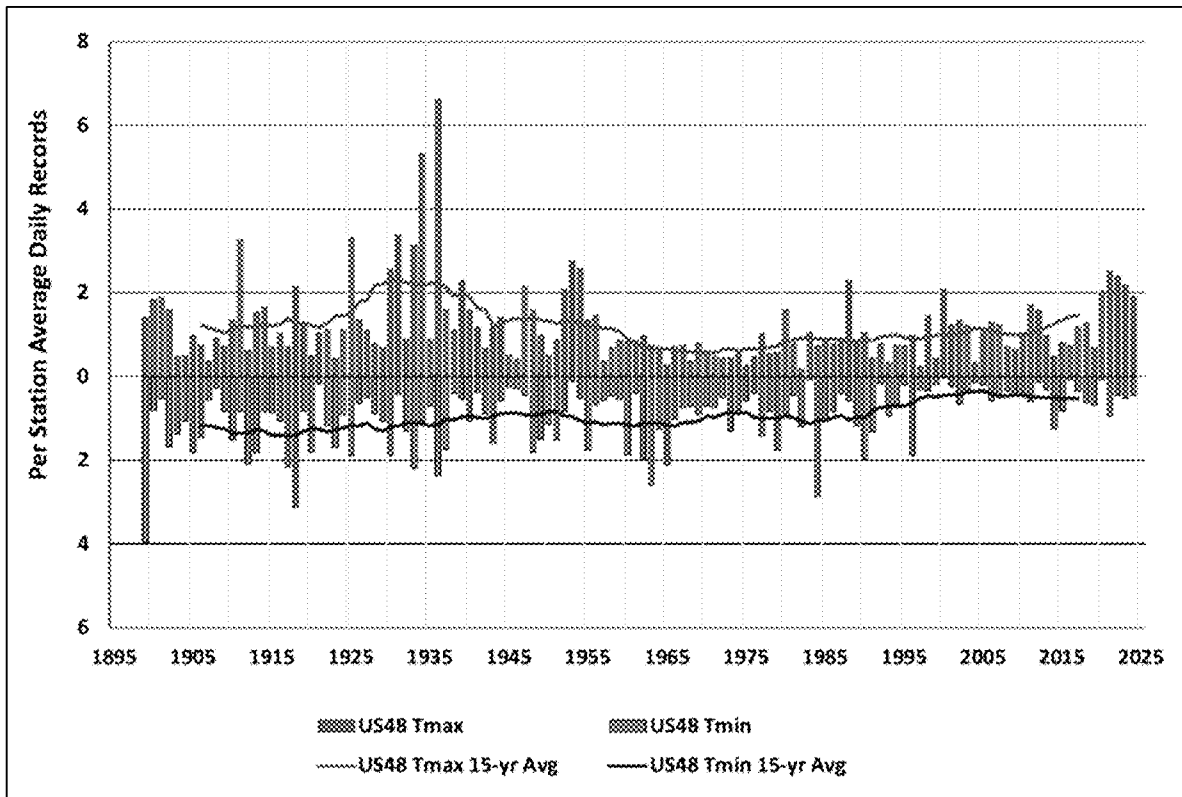
and offers this figure in support:



The figure appears to validate the claim that record warm daily temperatures are occurring more often. But the underlying data do not. Rather, they show that extreme heat in the U.S. peaked in the 1920s and 1930s and declined thereafter, as supported by Figure 6.4 deep within the CSSR itself (reproduced in our Section 4.2 below).

Figure ES.5 does not even show what its title implies, as it displays not simple counts of cold and warm extreme events, but rather ratios of the two counts. In fact, both types of extremes declined over the sample interval, but cold events declined more than warm events, so the ratio of warm extremes to cold extremes increased. By graphing the ratio instead of counts, NCA4 creates a visual impression opposite to what is in the data.

Figure 6.3.3 of CWG25 (reproduced below) shows the results of a proper analysis of the data – defining each record as the singular extreme in the sample interval, displaying numbers of warm and cold records separately, and beginning the analysis in 1899 rather than 1930. It makes evident the exceptional heat of the 1920s and especially the 1930s, peaking in 1936. The increased heat of the past five years is too brief to be deemed climatically significant and, in any event, occurred after the CSSR was published in 2017. The frequency of cold records has declined, especially over the last quarter of the period in which only 13 percent of the extreme cold events were measured. In contrast, 25 percent of the heat records were achieved in the last quarter, which is consistent with statistical expectations. As a result, the ratio of heat to cold extremes shown in Figure ES.5 of the CSSR explodes in recent decades. The overall reduction in numbers of both cold and hot extremes over the past century indicates a climate *less* prone to extremes, in sharp contrast to the message of NCA4 Figure ES.5.



Number of daily record High (red) and Low (blue) temperatures for warm and cold seasons in the CONUS. The lines represent the 15-year running, centered average. Source: 1,211 USHCN stations supplemented as needed to achieve a minimum of 92 percent of observations in the 126-year period since Dec 1898. US48: contiguous U.S. states. Tmax: maximum temperature. Tmin: minimum temperature. Source: CWG25 Figure 6.3.3.

The National Academies' expert review panel criticized the discussion of temperature extremes in a late draft of the CSSR. In reference to the CSSR's Key Finding 2 of Chapter 6, they said:

Further, it is difficult to understand how a statement that includes increases in extreme warmth can be associated with a high confidence or extremely likely statement, given that most of the graphics in this chapter show a decrease in extreme warmth in the historical record.

The Federal official in charge of the CSSR (Michael Kuperberg, Executive Director of the USGCRP) responded to the Academies' review by noting that

Almost every recommendation from the NAS was incorporated [in the final version]... and a new figure was added on changes in record high and low temperatures

The "new figure" referred to is the Figure ES.5, which did not appear in the draft reviewed by the Academies' panel. It seems unlikely that the Academies panel ever saw that figure because they surely would have commented if they had and it wouldn't have survived to publication. And the

figure's problems were evidently not flagged (or were ignored) in the subsequent internal government reviews.

With this background we now present our critique of NCA5.

2 NCA5 OVERVIEW CHAPTER: HYPERBOLIC ADVOCACY LANGUAGE AND UNSCIENTIFIC TONE

NCA5 Chapter 1, "Overview", holds a prominent place in the Report since it summarizes the entire report and is the only section that many will read. Although the later chapters of NCA5 contain much sound scholarly content, Chapter 1 is marred by an activist tone and language that aggressively promotes mitigation policies. As such, this chapter adds an imprimatur of scientific authority to oversimplified declarations of opinion about public policy. Many examples can be cited; here we note a few that are particularly egregious.

Chapter 1 opens as follows:

The more the planet warms, the greater the impacts. Without rapid and deep reductions in global greenhouse gas emissions from human activities, the risks of accelerating sea level rise, intensifying extreme weather, and other harmful climate impacts will continue to grow. Each additional increment of warming is expected to lead to more damage and greater economic losses compared to previous increments of warming, while the risk of catastrophic or unforeseen consequences also increases.

This statement presupposes that all warming is anthropogenic, that all warming is bad and causes economic damage, and that warming intensifies extreme weather. Such sweeping generalizations go well beyond what science has or can establish. The statement also refers to growing risks without saying whether they were large to begin with -- a small risk that grows may still be a small risk, and a large risk may be only incrementally worsened. A scientifically-sound version of this paragraph would instead say something like the following:

The Earth is warming because of a combination of natural and anthropogenic influences. This warming will generate a mix of benefits and harms that varies by region, to which society should be prepared to adapt. Some types of extreme weather have worsened recently, while others have not changed or have even declined in intensity. Reducing emissions of greenhouse gases might slow the warming although such policies have proven to be costly and disruptive, so any climate actions to be weighed against the potential benefits.

On the next page the Overview states:

Each additional increment of warming leads to greater risks [here it lists 7 key components of society including food security and the economy]... Without deeper cuts in global net emissions, climate risks to the US will continue to grow... Action to limit future warming and reduce risks can have near-term benefits and opportunities: low-carbon energy jobs, Improved air quality, Health benefits, Economic benefits..."

The authors write as if climate policy does not involve trade-offs and all measures to reduce future warming will be effective and beneficial. But the vast body of scholarship on climate science and economics does not support such simplistic claims. Not every additional increment of warming leads to economic harms; in fact, NCA5 Chapter 19 acknowledges that there will also be benefits. Nor is climate policy guaranteed to create jobs or benefit the economy; in many cases it has done the opposite. Such deceit is a disservice to policymakers.

Pages 8 and 9 of the Overview promote renewable energy options by noting, correctly, that the levelized costs of wind/solar generation have fallen sharply since 2010, and so offers this rationale for pursuing deep emission reductions:

Recent growth in the capacities of wind, solar, and battery storage technologies is supported by rapidly falling costs of zero- and low-carbon energy technologies, which can support even deeper emissions reductions. For example, wind and solar energy costs dropped 70% and 90%, respectively, over the last decade, while 80% of new generation capacity in 2020 came from renewable sources.

Yet it has long been known that intermittent renewables generation must be supplemented by dispatchable generation to meet grid reliability standards, and that doing so (e.g., through natural gas, fission, or storage) significantly increases the cost of electricity. Further, there are yet unmet synchronization challenges in transmission grids with heavy penetration of wind and solar power. Here again it is advisory malpractice not to acknowledge these facts.

Page 14 of the Overview presents future emission scenarios with the following description: “Climate modeling experts develop global climate projections for a range of plausible futures.” The word “plausible” is applied to all of the scenarios. The accompanying Figure includes both SSP3-7.0 and SSP5-8.5, the latter reaching the same radiative forcing as RCP8.5. The Figure does not compare observed emissions with previous projections nor does it caution readers that SSP3-7.0 and SSP5-8.5 are extreme worst case scenarios that, like RCP8.5, have been heavily criticized in the scientific literature (CWG25 3.2.1). By describing the entire envelope of emission projections as “plausible” the report opens the door to later presenting impacts associated with extreme and implausible emission scenarios as part of a baseline “business-as-usual” future.

Page 17 of the Overview introduces the discussion of risks from extreme weather events by saying “Harmful impacts from more frequent and severe extremes are increasing across the country.” This creates the impression that disaster losses are driven by trends in extreme weather. While the section goes on to acknowledge that some of the increase is due to increases in the value of assets at risk it then invokes the NOAA Billion Dollar Dataset as evidence of extreme weather getting worse. Scientists have shown that this is an invalid metric (CWG 10.2) since it measures the growth of the economy not the frequency of extreme weather, and indeed NOAA has recently withdrawn the data product (Pielke Jr. 2024, 2025). Even though it was still distributed by NOAA at the time of the NCA5, the report authors should have assessed it skeptically and seen that it was unfit for the purpose of measuring climate trends.

Page 23 of the Overview states, in large font:

Climate changes are making it harder to maintain safe homes and healthy families; reliable public services; a sustainable economy; thriving ecosystems, cultures, and traditions; and strong communities.

It is pointless to try to evaluate this statement on scholarly grounds; it is self-evidently hyperbolic. This kind of language doesn't belong in a scientific assessment report. Its prominent inclusion points not only to the willingness of NCA5 authors to promote alarm, but also the ineffectiveness of the review process in not ensuring such statements are removed.

The tone of the Overview chapter hints at the priorities that governed the writing of the entire report. Word counts of the full report are another crude indicator of those priorities. Table 1 lists word occurrences in NCA5 compared to occurrences in the CWG25 report. The contrasts are only partly attributable to differences in length, they primarily arise from different priorities of the author teams.

Term	NCA5	CWG25
Forcing	111	85
Uncertainty	384	21
Watts, W/m ²	31	16
Culture/culturally	854	0
Equity/equitable	572	0
Indigenous	890	0
Sustainable	295	1
Racism/racial	153	0

Table 1: Word occurrences in NCA5 and CWG25 reports.

3 OVERCONFIDENCE WHEN STATING CONCLUSIONS

3.1 Inflated certainty levels

Overconfidence in stating conclusions is an endemic problem in NCA5. The authors frequently make sweeping generalizations without appropriate caveats or acknowledging uncertainties. The overconfidence begins with inflated language to describe certainty levels.

NCA5 uses specific terms to convey information about scientific confidence associated with important finds, observations and projections. The Front Matter of NCA5 states that

confidence in a finding is based on the type, amount, quality, strength, and consistency of evidence; the skill, range, and consistency of methods to detect, evaluate, attribute, and interpret climate trends; and the degree of agreement across scientific information sources.

and Table 1 from the Front Matter provides calibrated language for confidence assessment:

Very high:	Strong evidence (established theory, multiple sources, well documented and accepted methods, etc.). High consensus
High:	Moderate evidence (several sources, some consistency, methods vary and/or documentation limited, etc.). Medium consensus
Medium:	Suggestive evidence (a few sources, limited consistency, methods emerging, etc.) Competing schools of thought.

Low: Inconclusive evidence (limited sources, extrapolations, inconsistent findings, poor documentation and/or methods not tested, etc.). Disagreement or lack of opinions among experts.

This terminology is inflated: *high confidence* with just moderate evidence and medium consensus; *medium confidence* with only suggestive evidence and competing schools of thought. This inflation in terminology leads to overconfidence in conclusions.

Even with this inflated terminology, NCA5 further inflates the confidence level of many of its conclusions to well beyond what the IPCC has concluded with more thorough justification, and also by incorrectly applying its own standards. The following example illustrates with respect to the conclusion regarding anthropogenic influence on climate change, arguably one of the most important scientific statements of the report.

Key Message 3.1 Traceable Account states:

There is *very high confidence* that emissions of GHGs from human activities, fossil fuel use in particular, have unequivocally caused *all* global warming observed over the industrial era.

while the corresponding statements from IPCC AR5 and AR6 are

AR5: It is *extremely likely* that *more than half* of the observed increase in global average surface temperature from 1951 to 2010 was caused by the anthropogenic increase in greenhouse gas concentrations and other anthropogenic forcings together.” (IPCC, 2013)

AR6: The *likely* range of total human-caused global surface temperature increase from 1850–1900 to 2010–2019 is 0.8°C to 1.3°C, with a best estimate of 1.07°C. It is *likely* that well-mixed GHGs contributed a warming of 1.0°C to 2.0°C, other human drivers (principally aerosols) contributed a cooling of 0.0°C to 0.8°C, natural drivers changed global surface temperature by –0.1°C to +0.1°C, and internal variability changed it by –0.2°C to +0.2°C. It is *very likely* that well-mixed GHGs were the main driver of tropospheric warming since 1979.

The IPCC AR5 and AR6 statements provide likelihood assessments but not a confidence level. While NCA5 claims with *very high confidence* that fossil fuels have unequivocally caused *all* global warming, AR5 refers to “*more than half* of the observed warming” and AR6 provides a more nuanced statement that relates to a *likely* range of warming contributed to by human drivers.

Quite separately we note that the attribution of various changes to “climate change” is misleadingly ambiguous. Because NCA5’s Glossary defines “climate change” as a change in climate for any reason, the statement is a tautology and so the attribution is superfluous. But because the popular perception of climate change is anthropogenic, its gratuitous inclusion effectively attributes the changes to greenhouse gas emissions

3.2 Overstating findings in underlying sources

Although we did not do a detailed audit of NCA5’s use of source material, spot checks turned up evidence of a pattern of overstatement.

Chapter 2 page 11 reports on an increase in precipitation in some areas and attributes it to human caused climate change:

Many eastern regions of the country are getting wetter (Figure 2.4). Average annual precipitation from 2002-2021 was 5%-15% higher relative to the 1901-1960 average in the central and eastern US, a trend attributable to climate change.

Note that this a non-standard metric; we will discuss NCA5's inconsistent choices of time scales of analysis below. The claims were attributed to the following paper:

- Knutson, Thomas and Fanrong Zeng (2018) "Model Assessment of Observed Precipitation Trends over Land Regions: Detectable Human Influences and Possible Low Bias in Model Trends" *Journal of Climate* 31(12)
<https://journals.ametsoc.org/view/journals/clim/31/12/jcli-d-17-0672.1.xml>

But Knutson and Zeng did not say these things. They examined linear trends over 1901 – 2010, 1951 – 2010 and 1981 – 2010. They did not compare average rainfall over 2002 - 2021 to average rainfall over 1901 – 1960, if only because their study was published in 2018. For 1981-2010, they noted stronger trends in some areas but cautioned that such changes are consistent with natural variability, and they did not claim attributable trends were observed over the United States:

Observed annual precipitation trends over the recent 30-yr period 1981–2010 (Fig. 5) have generally stronger magnitudes (in mm yr⁻¹ decade⁻¹) than observed trends for 1901–2010 or 1951–2010. This is as expected since trends over a shorter period have stronger potential for occurrence of pronounced temporary trends due to internal variability alone. Only 9% of the analyzed area has detectable and attributable anthropogenic influence (categories -3, -2, +2, +3), which represents less than one-third of the fractional areal coverage of such trends for 1901–2010 (29%). ... Eight percent of the analyzed area has attributable anthropogenic *increases* (categories +2, +3), including parts of eastern Europe, northern Asia, northern Australia/Maritime Continent, and tropical Africa.

As another example of overstating findings, NCA5's Chapter 2 page 18 states

There is robust evidence that human-caused warming has contributed to increases in the frequency and severity of the heaviest precipitation events across nearly 70% of the US.

This is allegedly attributed to two papers:

- Diffenbaugh, N.S., D. Singh, and J.S. Mankin, 2018: Unprecedented climate events: Historical changes, aspirational targets, and national commitments. *Science Advances*, **4** (2), 3354.
<https://doi.org/10.1126/sciadv.aao3354>
- Kirchmeier-Young, M.C. and X. Zhang, 2020: Human influence has intensified extreme precipitation in North America. *Proceedings of the National Academy of Sciences of the United States of America*, **117** (24), 13308-13313. <https://doi.org/10.1073/pnas.1921628117>

Diffenbaugh *et al.* presented ratios of observed occurrences of extreme events to simulated occurrence rates in CMIP6 models run with only natural forcings. They report that for 79% of the U.S.

extreme rainfall event frequencies are currently higher than in model simulations, and the ratio of occurrences will rise under future warming simulations. This is not “robust” evidence of anthropogenic influence since it requires readers to assume that climate models provide accurate simulations of regional precipitation patterns, something that even IPCC AR6 admits is uncertain (AR6 WGI SPM Box SPM 1.2, SPM Section C.1.3).

Kirchmeier-Young and Zhang looked at extreme 1- and 5-day events in North America and, using three GCMs, found

A signal of combined anthropogenic and natural external forcing can be detected in the intensification of extreme precipitation at the continental scale over North America. In some cases, this intensification can be attributed to human influence specifically.

However, they noted large differences among the three models in their simulated precipitation changes. Also, two of the three models failed to yield attribution for 5-day events for the North America mean. In other words the models disagreed on whether the observed changes were due to anthropogenic activity. Both cited references utilized the implausible RCP8.5 scenario and began their “historical” observational records only in 1961. Here again this is not “robust” evidence, it is merely suggestive, particularly since other studies have found natural variability predominant.

3.3 Technical example: Emergent constraints

Some of the overconfidence expressed by NCA5 arises by omitting discussion of counterevidence in the peer reviewed literature. An example is the topic of “emergent constraints”. Chapter 3 page 17 invokes this concept to support its claim that key uncertainties have been reduced:

An approach to reduce uncertainty in climate change projections has matured over the past decade. It is known as “emergent constraints.” The term refers to strong statistical relationships between highly uncertain future climate parameters and observable trends or variations in the current climate, along with a physical explanation of this relationship.

Emergent constraints appeared in the climate modeling literature as an attempt to tie GCM behavior to climate observations in hopes of generating insight into real-world equilibrium climate sensitivity to a doubling of carbon dioxide (ECS). Climate models exhibit a wide range of ECS values. The idea of emergent constraints is to examine whether the models with shared sensitivity values also share a common representation of some climate process (usually related to clouds) that might indirectly influence ECS. Suppose, for instance, that in low-ECS models the total cloud fraction in the tropics is strongly correlated with that in the southern midlatitudes but in high-ECS models the correlation is weak. Then researchers could examine whether the observed correlation is strong or weak and draw a conclusion about which type of model, and therefore which ECS value, is more likely.

A problem in the emergent constraint literature is that there has been a proliferation of proposed correlations with little physical motivation. Many emergent constraints patterned on CMIP5 models failed to work on CMIP6 models (Schlund *et al.* 2020). In other words, the observed correlations in CMIP5 models between ECS and cloud processes failed to show up in CMIP6 models, indicating that they were likely spurious rather than clues to physical processes governing the Earth climate system. The result was that emergent constraints estimated from CMIP5 models widened the range of estimated ECS values when applied to CMIP6 models.

Schlund *et al.* summarized the problem as follows [**boldface** used for emphasis]

In this study, we systematically analyze 11 published emergent constraints on ECS that have mostly been derived from models participating in the Coupled Model Intercomparison Project Phase 5 (CMIP5) project... The focus of the study is on testing if these emergent constraints hold for [Earth System Models] participating in the new Phase 6 (CMIP6). Since none of the emergent constraints considered here have been derived using the CMIP6 ensemble, CMIP6 can be used for cross-checking of the emergent constraints on a new model ensemble. **The application of the emergent constraints to CMIP6 data shows a decrease in skill and statistical significance of the emergent relationship for nearly all constraints, with this decrease being large in many cases.** Consequently, the size of the constrained ECS ranges (66% confidence intervals) widens by 51% on average in CMIP6 compared to CMIP5.

Yet NCA5 described the use of emergent constraint analysis as a great “advance” that reduced uncertainty.

4 RELIANCE ON *Ad Hoc* TIME SCALES FOR TREND ANALYSIS

In CWG25 Chapter 6 we discussed the need for care in the choice of time scale when making claims about trends in extreme weather. We provided examples from analysis of river flooding, heatwaves, and extreme precipitation to show how assertions about apparent trends based on short data sets fall apart when looking at longer versions of the same data sets. Here we elaborate on these examples to illustrate the general point that NCA5 made inconsistent and *ad hoc* choices about time scales of analysis, weakening the validity of their conclusions.

4.1 Average and Extreme Precipitation

McKittrick and Christy (2019) showed that apparently significant positive trends in U.S. average and extreme precipitation over the NCA4 interval (1901 – 2016) disappeared on longer samples (extending back as far as the 1840s, depending on location) or on a shorter interval coinciding with the final 40 years of the data then available (1978 – 2017). In CWG25 Section 6.4 we presented analyses of updated data for the same locations (and many others), in all cases finding both considerable regional heterogeneity and that trends detectable on one time scale are often not detected on longer or shorter time scales. These findings argue against simple attribution of changes to anthropogenic influences.

NCA5 did not continue the NCA4 precedent of using the post-1901 interval as the time scale for its precipitation discussion; instead it refers to changes “since the 1950s”; NCA5 Figure 2.8 suggests 1958 might be the intended start date. Under Key Message 2.2 “Extreme Events Are Becoming More Frequent and Severe” (p. 2-16) NCA5 states (p. 2-18):

Rainfall is becoming more extreme
Since the 1950s, there has been an upward trend in heavy precipitation across the contiguous US. This increase is driven largely by more frequent precipitation extremes, with relatively smaller changes in their intensity.

In addition to our concerns that inferences about trends are contingent on choice of time scale, we cannot reproduce the finding that positive trends are observed in extreme precipitation across all CONUS regions. We extended the data used in CWG25 (McKittrick and Christy 2025) to include 141 stations across the US in the Pacific Coast, Midwest, Northeast and Southeast regions (Christy 2025). See details in Appendix 3. Many post-1950 trends are positive but statistically insignificant depending on the measure of extreme precipitation. It is possible to find locations that support the NCA5 position, such as the Southeast post-1950, but results are not robust to selecting longer or shorter time scales of analysis nor do they generalize across all regions.

The following is a more accurate summary of what U.S. data show.

There are regionally heterogeneous changes in average and extreme precipitation. Positive trends in annual average rainfall and extreme events (defined either as the annual maximum or the number of exceedances of the 99th percentile value) are generally weak or non-existent when looking at samples exceeding 130 years in length. Significant trends can be found when beginning the sample in the 1950s although in most cases the trends weaken and become insignificant when looking at the post-1980 interval. This makes attribution of changes in precipitation to anthropogenic warming difficult.

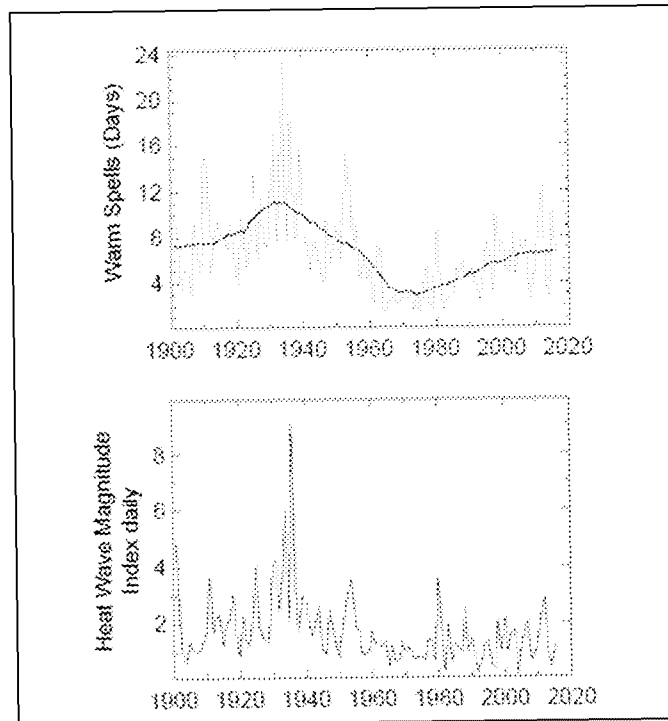
4.2 Heatwaves

In contrast to NCA5, NCA4 examined heat extremes across the entire 20th century, pointing out that peak heat wave activity was reached in the 1930s and has decreased since then, and that recent increases are confined to areas west of the Rockies:

[The] warmest daily temperature of the year increased in some parts of the West over the past century, but there were decreases in almost all locations east of the Rocky Mountains. In fact, all eastern regions experienced a net decrease, most notably the Midwest (about 2.2°F [1.2°C]) and the Southeast (roughly 1.5°F [0.8°C]).

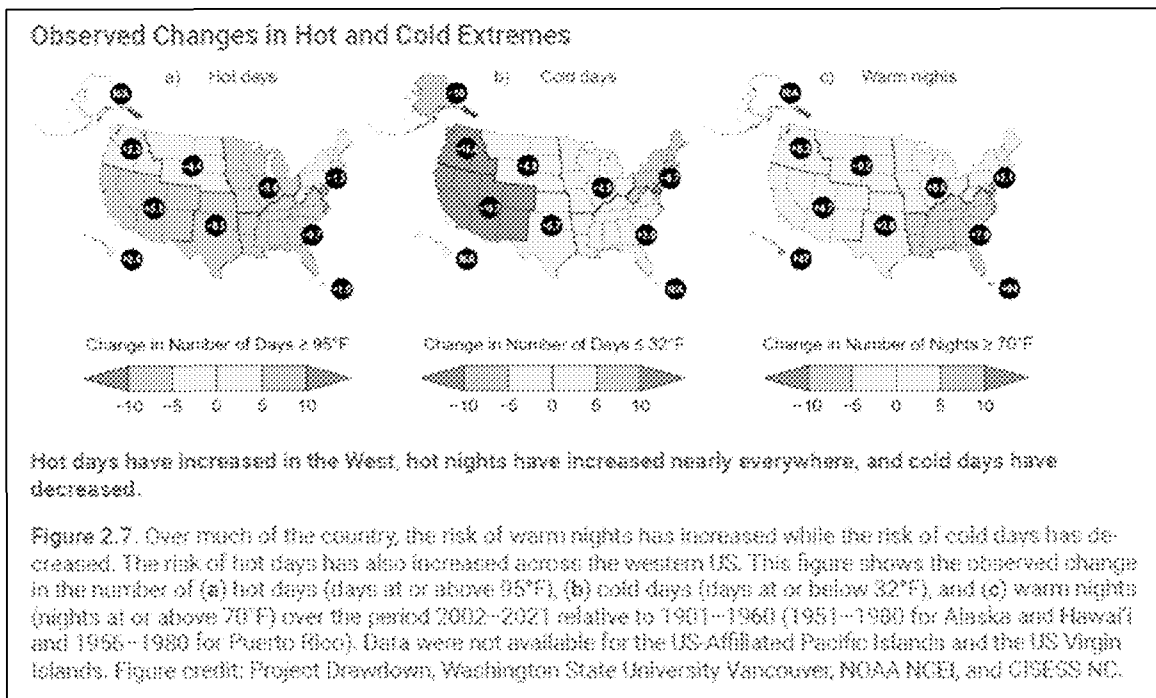
Since the mid-1960s, there has been only a very slight increase in the warmest daily temperature of the year (amidst large interannual variability). Heat waves (6-day periods with a maximum temperature above the 90th percentile for 1961–1990) increased in frequency until the mid-1930s, became considerably less common through the mid-1960s, and increased in frequency again thereafter. As with warm daily temperatures, heat wave magnitude reached a maximum in the 1930s.

(NCA4 pp. 190-191)



U.S. Heat waves since 1900. Source: NCA4 Figure 6.4

Contrast this careful and factual language with NCA5 Key Message 2.2: “Extreme Events Are Becoming More Frequent and Severe.” This blanket statement is followed by NCA5 Figure 2.7 (reproduced below) which shows the number of hot days, cold days and warm nights (respectively in panels a—c) over the period 2002-2021 compared to 1901-1960. [Presumably these are annual counts, although not stated in the caption.]



Close inspection shows that this figure contradicts the NCA5 Key Message with respect to heatwaves and instead reinforces the position of NCA4. Notwithstanding Key Message 2.2 the leftmost panel in Figure 2.7 above shows that over most of CONUS the number of extreme heat days has decreased in recent decades compared to the prior century.

The accompanying discussion in NCA5 becomes convoluted as it appears to be aimed at supporting the Key Message despite the contrary evidence. NCA5 chapter 2 elaborates on Key Message 2.2 by saying (page 16):

Observations show an increase in the severity, extent, and/or frequency of multiple types of extreme events. Heatwaves have become more common and severe in the West since the 1980s (*high confidence*).

But while it mentions the increase in hot days in the west it fails to mention the decrease everywhere east of the Rockies. On the next page (page 17) it raises the comparison to the 1930s then switches to discussing global counts:

By some measures, the most extreme heatwaves on record in the United States occurred during the Dust Bowl era of the 1930s. ... Globally such heatwaves are becoming more frequent, and in recent decades the western United States has been following those trends.

The reference to a global trend seems to be an attempt to tie heatwaves to anthropogenic climate change. But the obvious question, unaddressed by NCA5, is why one region follows the global pattern of increasing heatwaves while most of the country is trending in the opposite direction. These issues are addressed in Chapter 6 of CWG25, demonstrating that the range and magnitude of extreme temperatures (10s of degrees) are driven more by natural variability than by the small anthropogenic forcing. The analysis in CWG25 shows that for both (a) hot days ($\geq 95^{\circ}\text{F}$) and (b) number of days in heatwaves, the current decade is no hotter than a century ago in the U.S. Thus, the NCA5 claim that

“multiday heatwaves have become hotter, more frequent, larger, and longer lasting in recent decades,” is simply false when expanding the temporal and spatial domains to encompass all available data (Chapter 6 and Figure 6.3.6 of CWG25).

NCA5 then pointed to the dramatic Pacific Northwest heatwave of 2021. CWG2025 Section 8.6.1 discussed this event in detail, reviewing the multiple peer reviewed studies that explained the unusual meteorological context was unrelated to human-caused climate change, a point omitted from the NCA5 discussion.

NCA5 finally addresses the declining heatwave trend in CONUS east of the Rockies but attempts to reframe it by focusing on urban warm spells.

[The] number of very hot days has actually decreased across the central and eastern regions due to summer cooling trends in the region (Figure 2.7; Ch. 22). This does not, however, mean the central and eastern US are not affected by heat. The impacts of extreme high temperatures are more severe if such conditions persist for several days, and overall, multiday heatwaves have become hotter, more frequent, larger, and longer lasting in recent decades. Across 50 large US cities, the US Global Change Research Program heatwave indicator (<https://www.globalchange.gov/indicators/heat-waves>) shows that the average number of heatwaves has doubled since the 1980s, and the length of the heatwave season has increased from about 40 days to about 70 days.

We discussed part of NCA5 in CWG25 Section 6.3. The figure referenced by NCA5 uses an *ad hoc* definition of heat wave, namely two consecutive days with minimum nighttime temperatures above the 85th percentile, and an *ad hoc* time scale which begins in the 1960s, the coldest decade in the last century, thus suppressing any comparison to the 1930s. Further, nighttime temperatures in urban areas have increased faster than daytime temperatures (which NCA5 acknowledges), but this is a signature of urban heat islands and not a good metric of climate change. CWG25 noted as well that the occurrence of hot days ($\geq 95^{\circ}\text{F}$) has recently increased in the West, but declined in the remainder of the country, and in the nationwide average, since 1899.

5 INADEQUATE TRACEABLE ACCOUNTS

NCA3 began the practice of including a section on Traceable Accounts at the end of each chapter. This is the description from NCA5:

Each chapter concludes with a section entitled Traceable Accounts, which provides information on the overall process used to develop the chapter as well as a separate Traceable Account section for each Key Message. These Traceable Accounts describe the supporting evidence behind each Key Message, the process and rationale authors used in reaching their conclusions, and the author team’s expert assessment of the confidence in and, where applicable, likelihood of these conclusions. As such, Traceable Accounts provide information about the state of the science, document sources of uncertainty, identify research gaps, and allow traceability to data and resources.

The Traceable Accounts for each Key Message includes the following sections:

- Description of Evidence Base
- Major Uncertainties and Research Gaps
- Description of Confidence and Likelihood

The Traceable Accounts could in principle address the statutory requirement that the NCA discuss scientific uncertainties. They could also help satisfy the Executive Order for Restoring Gold Standard Science by addressing reproducibility, transparency, communication of error and uncertainty, and skepticism of findings and assumptions. However, the Traceable Accounts in NCA5's Chapters 2 and 3 (the only chapters investigated here) are uneven, often superficial and noninformative.

An example of a deficient Traceable Account is NCA5's Key Message 2.2: "Extreme Events are Becoming More Frequent and Severe". The "Description of the Evidence Base" offers two paragraphs, the first summarizing the findings and the second generically describing the types of data that can be used for storms. "Major Uncertainties and Research Gaps" focuses on the uneven distribution across U.S. populations due to differences in exposure and vulnerability. The only limitations in data referred to are the lack of a long-term record of lightning and the lack of homogenized daily and hourly temperature data apart from reanalysis products.

But the most astonishing deficiency is in the "Description of Confidence and Likelihood." One of the statements in Key Message 2.2 is:

Hurricanes have been intensifying more rapidly since the 1980s (high confidence) and causing heavier rainfall and higher storm surges (high confidence).

The Description of Confidence and Likelihood includes the following statement:

Basic physical understanding and climate models both provide robust explanations for the links between climate change and observed changes in these extremes: this is why the authors also have high confidence that storms are delivering more rainfall and high confidence that storm surges are becoming higher.

No reference to journal publications or a specific data set is made in the Chapter regarding hurricane induced precipitation or storm surge to support this *high confidence* conclusion.

The Traceable Accounts for the various Key Findings of Chapter 3 have some substantial inconsistencies. Consider

Key Message 3-1: Human activities have caused global warming.

Confidence and Likelihood: "There is *very high confidence* that emissions of GHGs from human activities, fossil fuel use in particular, have *unequivocally* caused all global warming observed over the industrial era. There is also *very high confidence* that changes in natural climate drivers have had globally small and regionally variable long-term effects over this period."

The Uncertainties section addresses only uncertainties in radiative forcing by greenhouse gases. In contrast, the Traceability Analysis of Key Message 3-4 ("Humans Are Changing Earth System Processes") raises the problem that relatively little is known about the role of natural variability at the regional scale. From its Description of Evidence Base:

In the last decade, there has been increasing recognition of the role of regional-scale natural variability in the past and future evolution of climate, as well as the fact that regional natural variability signals can be competitive with forced anthropogenic signals.

And from its Major Uncertainties and Research Gaps:

For example, the true natural variability of the climate system on decadal to centennial timescales could be larger than what we estimate from GCMs, which would further increase the irreducible uncertainty stemming from natural variability.

These statements are among the most scientifically credible in the entire NCA5 and they directly undercut the confidence assigned to Key Message 3-1.

There is also a generic problem in tracing NCA5's Traceable Accounts. The Front Matter of NCA5 states:

Each figure and some tables are accompanied by a metadata survey, which can be accessed in the online version of the report by clicking on the eyeball icon above the figure or table (see the table below for explanations of additional icons used throughout the report). The metadata survey describes data sources, figure or table development methods, copyright information, and other important documentation.

Upon clicking on the eyeball icon above a particular figure, a "Contact Us" email appears, addressed to the USGCRP. No attempt was made to send a email to elicit the Metadata information, but it is clear that this information is not readily accessible online.

In summary, the Traceable Analyses examined here, with few exceptions, fail to meet the stated objectives set forward by the NCA.

6 OVEREMPHASIS ON EXTREME SCENARIOS

To respond to the GCRA mandate to "project major trends for the subsequent 25 to 100 years," NCA5 relies on projections of future climate change based on estimates of future emissions (the so-called SSP scenarios) and/or specified levels of radiative forcing (the RCP scenarios). For the most part, NCA5 uses scenarios developed for the IPCC Assessment Reports.

In CWG Section 3.2.1 we presented a critical assessment of past and current IPCC scenario envelopes, showing that they have tended to overshoot observed emissions. The IPCC AR6 published in 2021 stated that "The likelihood of high-emission scenarios like RCP8.5 and SSP5-8.5 is considered low in light of recent energy sector developments." and that same year UN Climate Negotiators (COP) stopped using scenarios above 4.5.

NCA5 makes the following observations about the scenarios they use:

NCA5 authors were advised to assess the full range of scenarios available. (Front Matter)

Scenarios of future emissions and land-use change are developed as plausible alternatives, but no relative likelihood is attached to them. Some recent studies, however, have argued that the highest scenario, SSP5-8.5, is no longer plausible without a reversal of current trends in the adoption of renewables and energy efficiency. (Key Message 3.3 Traceable Analysis)

Despite acknowledging the issue, NCA5 otherwise ignored the problem. A keyword search of NCA5 of mentions of RCP/SSP scenarios finds over 50% referred to the extreme emissions scenarios RCP8.5/SSP5-8.5. Further, 10 NCA5 figures (5.2, 6.9, 7.4, 11.3, 14.6, 22.13, 22.19, 27.9, 29.13) included *only* the 8.5 scenarios.

The problem of relying on extreme scenarios is particularly acute for NCA5's sea level rise projections. The sea level rise scenarios used in NCA5 do not relate directly to the SSP emissions scenarios, but rather to specified amounts of sea level rise by 2100. Table 4 of NCA5's "Guide to Using this Report" reproduced below shows that Low relates to 0.3 m (0.98 feet), Intermediate-Low relates to 0.5 m (1.64 feet), Intermediate relates to 1.0 m (3.28 feet), Intermediate-High relates to 1.5 m (4.92 feet), and High relates to 2.0 m (6.56 feet).

Table 4. Descriptive Terms for Common Sea Level Rise Scenarios Used in NCA5						
Future global mean sea level rise and sea level rise along United States coastline are shown for five scenarios in feet (and meters), relative to a 2000 baseline. The US values shown in the right half of the table are averaged across the US coastal regions, including the contiguous US, Alaska, Hawaii and the US-affiliated Pacific Islands, and the US Caribbean. The national values shown in the table differ substantially from regional values. For example, sea level rise is higher in the Gulf Coast and lower or even negative in some parts of Alaska. In the next 30 years (2020–2050), sea level along the contiguous US coasts is expected to rise 0.92 feet (0.28 m), the same amount of sea level rise observed over the last 100 years (1920–2020). See Chapter 9 for regional sea level information. Adapted from Sweet et al. 2022. ⁹						
Sea Level Rise Scenario Descriptor	Global Mean Sea Level			United States		
Year	2050	2100	2150	2050	2100	2150
Low	0.49 (0.15)	0.98 (0.3)	1.31 (0.4)	0.59 (0.18)	0.98 (0.3)	1.64 (0.5)
Intermediate-Low	0.66 (0.20)	1.64 (0.5)	2.62 (0.8)	0.75 (0.23)	1.64 (0.5)	2.95 (0.9)
Intermediate	0.92 (0.28)	3.28 (1.0)	6.23 (1.9)	0.89 (0.27)	3.28 (1.0)	6.89 (2.1)
Intermediate-High	1.21 (0.37)	4.92 (1.5)	8.86 (2.7)	1.12 (0.34)	4.92 (1.5)	8.86 (2.7)
High	1.41 (0.43)	6.56 (2.0)	12.14 (3.7)	1.38 (0.42)	6.56 (2.0)	12.46 (3.8)

Table 4 from the Front Matter of NCA5

Considering only projections representing processes quantified with at least medium confidence, IPCC AR6 assessed global mean sea level projections for 2100 to fall between 0.2 and 1.6 m (5th—95th percentile range). Nevertheless, the range of sea level rise scenarios considered by NCA5 extends to 2.0 m. Further, NCA5 fails to include plausible lower scenarios, such as 0.2 m cited by the IPCC, which also corresponds to the average rate of sea level rise over the past century.

Chapter 9 of NCA5 offers the following predictions of sea level rise:

“Under a range of potential global warming levels, average sea level along US coastlines is *likely* to be between 12 and 20 inches above 2000 sea levels in 2050 (Figure 9.2).”

These values span from the Intermediate scenario to values slightly greater than the High scenario. They can be put into context by considering the observed global sea level rise from 2000-2024,

approximately 3.39 inches (0.28 feet). NCA5 is thus projecting a sea level rise during 2025 and 2050 that is 3.5 to 5.8 times the rate observed during 2000-2024. Chapter 9 further states:

“Looking toward the future, an 11 inch (28 cm) average rise along the contiguous US coastline is expected by 2050 (relative to 2020), with a *likely* range of 9-13 inches.”

...

“There is *high confidence* and it is *likely* that sea levels will rise about 11 inches (likely range of about 9–13 inches) between 2020 and 2050”

In summary, NCA5 presents future sea level rise scenarios that are not directly relatable to either SSP/RCP emissions scenarios nor to global warming levels. The NCA5 scenarios include two scenarios that are higher than the 95th percentile for the extreme emissions scenario RCP8.5 and include hypothesized ice sheet processes in which there is low confidence. Projections to 2050 require rates of sea level rise from 2025 to 2050 that are more than triple the rate observed during 2020-2024. Further, NCA5 ascribes *high confidence* to these sea level rise projections.

More generally, NCA5’s inclusion, and even focus, on implausible extreme emissions scenarios supports projections of alarming impacts that are very unlikely to be driven by anthropogenic warming.

7 INADEQUATE NASEM REVIEW: TO BE ADDED

I THINK WE SHOULD DELETE THIS CHAPTER, IT ISN’T VERY STRONG

The National Academies of Science, Engineering and Medicine (NASEM) undertook a detailed review of the draft NCA5 (NASEM 2023). While they raised some of the same concerns that we have articulated herein, their review is superficial overall and appears to be written by authors who share many of the biases of the NCA5 team. There is an inordinate focus on social and policy issues (e.g., every chapter is assessed under the heading “Comments on Equity and Justice”), rather than on the underlying science. In our assessment NASEM failed to apply the serious rigor one would expect. A few extracted comments from it will illustrate. Note that NASEM review comments are included here in blue font for reference.

7.1 Substantive criticisms by NASEM

- summarize the valid points made by NASEM and check the NCA replies

7.2 Failures to challenge NCA5 flaws

NASEM praised Chapter 2, saying:

The chapter [2] meets the requirements of Section 106 of the GCRA.

Yet contrary to the requirements of Section 106, Chapter 2 did not adequately discuss natural variability let alone assess the full climate record available for quantifying natural variability. Chapter 2 actually minimizes natural variability by claiming (unsubstantiated) skill in attributing recent extremes to human causes. For example NCA5’s Chapter 2 Introduction states,

“...recent advances in attribution science (KM 3.3) mean that the role of climate change in some extreme events can now be quantified in real time. For example, climate change made the record-breaking Pacific Northwest heatwave of June 2021 2° to 4°F hotter, and in 2017 ...”

CWG25 reviews the expert literature demonstrating that this particular event would have happened with or without climate change and that for CONUS, hot extremes are no more frequent now than they were in the past. NASEM did not challenge the unsubstantiated attribution claims in NCA5.

Notwithstanding NASEM’s claim that the Chapter complies with Section 106 of the GCRA, it then acknowledged the absence of discussion of natural variability:

...the discussion and references regarding the role of natural climate variability and its regional differences are missing.

While a nod to natural variability is occasionally found in NCA5, it is usually followed by a “however” to emphasize human influence. One example is the statement just before the claim mentioned above pertaining to extreme event attribution: “There has always been extreme weather, which occurs even in an unchanged climate due to the natural variability of the Earth system. However, recent advances in attribution science (KM 3.3) mean that the role of climate change in some extreme events can now be quantified in real time...”

We pointed out (Section 4.2) that the evidence regarding heatwaves directly contradicts Key Message 2.2. NASEM did not mention this, instead it focused on a somewhat esoteric issue of terminology:

“Extreme Events Are Becoming More Frequent and Severe.”

Key Message 2.2 is another generally well written key message. However, while the title of this key message includes the word “risk,” the key message is exclusively about hazard. The Committee suggests rewriting the key message title to more accurately reflect the discussion on hazards.

The NASEM review appears to accept NCA5’s use of short data records because it makes no critical remarks about the failure to assess long time series, except for its observation that the use of short records makes the omission of natural variability that much more of a problem:

It is also important to point out that the influence of natural climate variability becomes particularly strong when the climate trend is computed based on short periods of time or small geographic areas.

This comment was largely ignored in the NCA5 final text.

In sum, while the NASEM review might bestow the Academies’ imprimatur on the NCA5 report, it does not necessarily add to its quality for two reasons. As we have demonstrated, the NASEM review falls short in rigor and completeness. And second, the NCA authors are not obligated to follow the NASEM recommendations in crafting their final product.

8 SUMMARY EVALUATION OF NCA5

CHAPTER NEEDS A COMPLETE REWRITE

The most straightforward evaluation of NCA5 is through its statutory requirements. While it is not within our purview to make definitive rulings on compliance, we believe there are several important aspects to consider when evaluating NCA5 against its statutory requirements. Add text per Seth's letter ...

~~Our expertise in climate science, the foundational area covered by NCA5, allows a different perspective, one that finds the coverage unbalanced and selective. Our review has identified numerous instances where NCA5 falls short of the quality and integrity expected of scientific document of this importance. Furthermore, our examination suggests that the entire process—from the selection of contributing authors to the handling of expert reviews—appears to have been systematically biased toward reinforcing predetermined conclusions and amplifying alarmist messaging rather than presenting a balanced scientific assessment. In short, NCA5 was written to persuade, not inform.~~

~~A third perspective for evaluating NCA5 is that of citizens interested in good policymaking. The changing climate is a legitimate public concern, as are concerns about cost of living, economic growth, employment opportunities, and other socioeconomic factors. We share the widespread belief that elected officials should have access to the highest quality information when crafting energy and climate policy decisions that must balance multiple concerns. From this perspective, NCA5 is a missed opportunity. What could have been a valuable contribution to informed tradeoffs instead became a misleading advocacy document that corrupts the policymaking process.~~

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APPENDICES

APPENDIX 1: Charge to the review

APPENDIX 2: statutory requirements for NCA5

APPENDIX 3: Reproducibility of NCA5 claim of extreme precipitation trends

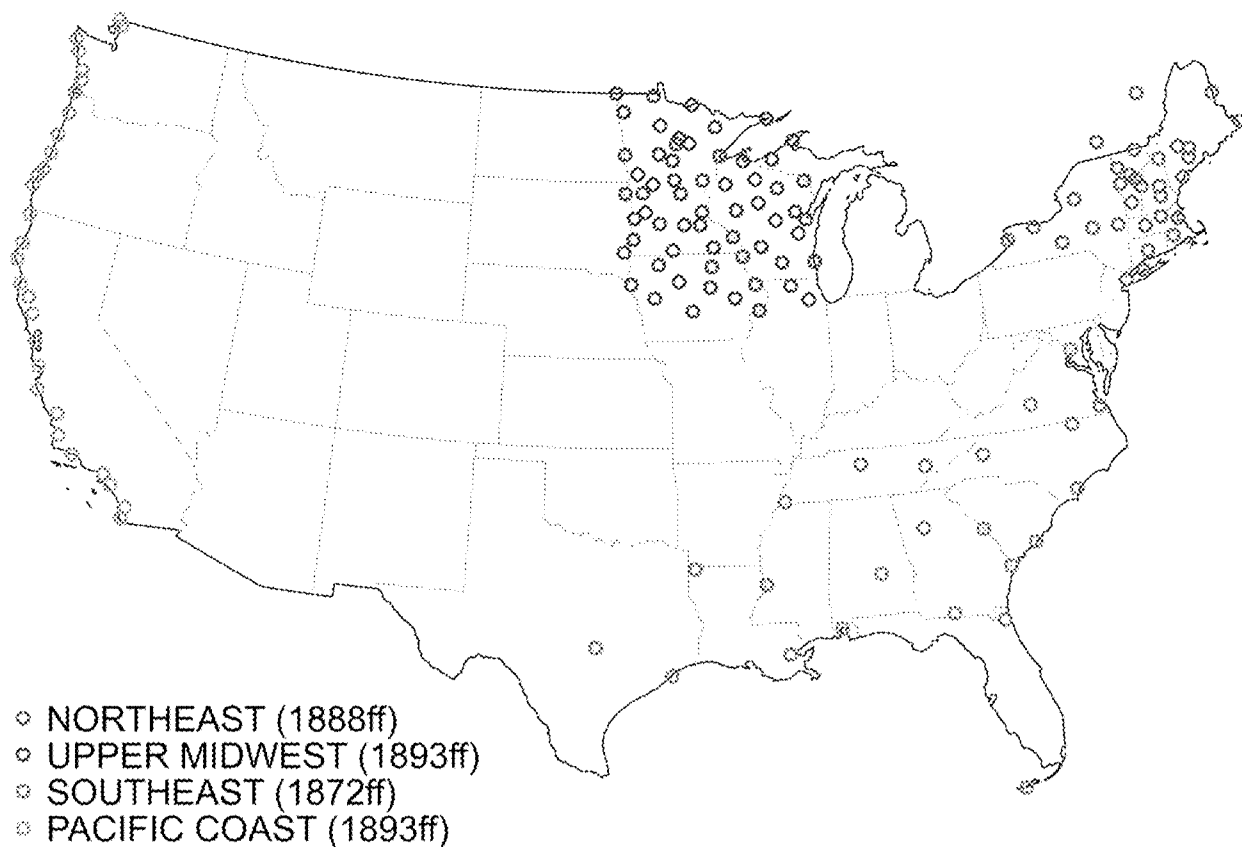


Figure A1: Stations used in the following analyses

Note: All data are available at Christy (2025). Methods as described in McKittrick and Christy (2019), code available at McKittrick and Christy (2025).

Table codes: (-) neg insignificant, -- neg significant, (+) pos insignificant, ++ pos significant.

Column 1: Measure

Column 2: Number of stations in that region

Column 3: Count of stations exhibiting a significant positive trend

Column 3: Count of stations exhibiting a significant negative trend

Column 5: Characteristic of region-wide trend

PACIFIC COAST

Since 1893:

	No. stns	+ trends	- trends	region
1-day average	29	0	1	(-)
2-day average	29	0	1	(-)
Avg on non-zero days	29	0	9	--
Variability	29	1	0	(+)
Annual max	29	2	1	(+)
Number of 99 th pct exceedances	29	1	0	(-)

Since 1950:

	No. stns	+ trends	- trends	region
1-day average	29	0	1	(-)
2-day average	29	0	1	(-)
Avg on non-zero days	29	0	4	(-)
Variability	29	2	3	(-)
Annual max	29	6	3	(-)
Number of 99 th pct exceedances	29	2	1	(-)

Since 1980:

	No. stns	+ trends	- trends	region
1-day average	29	0	0	(-)
2-day average	29	0	0	(-)
Avg on non-zero days	29	0	1	(-)
Variability	29	0	0	(-)
Annual max	29	2	1	(-)
Number of 99 th pct exceedances	29	0	0	(+)

SOUTHEAST

Since 1873:

	No. stns	+ trends	- trends	region
1-day average	24	1	1	(+)
2-day average	24	1	1	(+)
Avg on non-zero days	24	7	2	(+)
Variability	24	1	0	(+)
Annual max	24	2	0	(+)
Number of 99 th pct exceedances	24	5	0	(+)

Since 1950:

	No. stns	+ trends	- trends	region
1-day average	24	5	0	++
2-day average	24	5	0	++
Avg on non-zero days	24	5	1	++
Variability	24	6	0	++
Annual max	24	4	0	++
Number of 99 th pct exceedances	24	4	0	(+)

Since 1980:

	No. stns	+ trends	- trends	region
1-day average	24	5	0	(+)
2-day average	24	5	0	(+)
Avg on non-zero days	24	5	1	(+)
Variability	24	3	0	(+)
Annual max	24	4	0	(+)
Number of 99 th pct exceedances	24	4	0	(+)

MIDWEST

Since 1893:

	No. stns	+ trends	- trends	region
1-day average	61	23	0	++
2-day average	61	23	0	++
Avg on non-zero days	61	2	12	(+)
Variability	61	12	0	++
Annual max	61	9	0	(+)
Number of 99 th pct exceedances	61	10	0	(+)

Since 1950:

	No. stns	+ trends	- trends	region
1-day average	61	28	2	++
2-day average	61	28	2	++
Avg on non-zero days	61	11	1	++
Variability	61	16	0	(+)
Annual max	61	8	0	(+)
Number of 99 th pct exceedances	61	19	0	++

Since 1980:

	No. stns	+ trends	- trends	region
1-day average	61	6	1	(+)
2-day average	61	6	1	(+)
Avg on non-zero days	61	8	2	(+)
Variability	61	5	1	(+)
Annual max	61	0	1	(+)
Number of 99 th pct exceedances	61	5	3	(-)

NORTHEAST

Since 1888:

	No. stns	+ trends	- trends	region
1-day average	27	12	0	++
2-day average	27	12	0	++
Avg on non-zero days	27	7	1	(+)
Variability	27	4	0	(+)
Annual max	27	3	0	(-)
Number of 99 th pct exceedances	27	5	0	(+)

Since 1950:

	No. stns	+ trends	- trends	region
1-day average	27	12	0	++
2-day average	27	12	0	++
Avg on non-zero days	27	7	1	(+)
Variability	27	4	0	(+)
Annual max	27	3	0	(-)
Number of 99 th pct exceedances	27	5	0	++

Since 1980:

	No. stns	+ trends	- trends	region
1-day average	27	10	1	++
2-day average	27	10	1	++
Avg on non-zero days	27	6	0	(+)
Variability	27	2	0	(+)
Annual max	27	1	0	(+)
Number of 99 th pct exceedances	27	1	1	++

ABOUT THE AUTHORS

[Insert updated bios]

From: Roy Spencer <roywspencer@hotmail.com>
Sent: Thursday, July 17, 2025 6:43 AM
To: Steven Koonin; 'Judith Curry'; 'Ross McKittrick'
Cc: 'John Christy'; 'Travis Fisher'; 'Josh Loucks'; 'Seth Cohen'
Subject: Re: NCA5 progress - Roy's edits
Attachments: NCA5Review Curry SK Curry SK RS.docx

Attached find my edits added to Steve's version, so I assume John now works from this copy.
-Roy

From: Steven Koonin <steven.koonin@gmail.com>
Sent: Wednesday, July 16, 2025 5:29 AM
To: 'Judith Curry' <curry.judith@gmail.com>; 'Ross McKittrick' <ross.mckittrick@gmail.com>
Cc: 'John Christy' <climateman60@gmail.com>; 'Travis Fisher' <travis.scott.fisher@gmail.com>; 'Roy W. Spencer' <roywspencer@hotmail.com>; 'Josh Loucks' <loucksj14@gmail.com>; 'Seth Cohen' <seth.cohen@hq.doe.gov>
Subject: RE: NCA5 progress

And my further edits attached.

Do keep me at least cc'd over the next few days – I'll respond as I'm able.

SEK

From: Judith Curry <curry.judith@gmail.com>
Sent: Tuesday, July 15, 2025 7:05 PM
To: Ross McKittrick <ross.mckittrick@gmail.com>
Cc: John Christy <climateman60@gmail.com>; Steven Koonin <steven.koonin@gmail.com>; Travis Fisher <travis.scott.fisher@gmail.com>; Roy W. Spencer <roywspencer@hotmail.com>; Josh Loucks <loucksj14@gmail.com>; Seth Cohen <seth.cohen@hq.doe.gov>
Subject: Re: NCA5 progress

Here is my revised version. One proposed change of substance, relates to TX floods.

In section 8.3, i proposed modifying one of the bullets:

- The range of climatic and weather conditions, including extremes, that have occurred in the past and can reasonably be expected to occur in U.S. regions over the near future. An example of a salient acute failure is the NCA5 chapter (region that includes Texas) that fails to mention the historical occurrence and future risk of flash floods in the Texas Hill Country **ROSS MAYBE MENTION WHAT NCA5 SAID ABOUT TX FLOODS in REGIONAL CHAPTER, THEN INCLUDE LINK TO YOUR MINI ANALYSIS**

An alternative approach would be to add a new chapter on Failure to document the risk of extreme events based on the historical data base, something like that. Simpler just to mention it in Section 8.3

On Tue, Jul 15, 2025 at 3:33 PM Ross McKittrick <ross.mckittrick@gmail.com> wrote:

If Steve's away until Tuesday a Friday July 18 deadline won't be feasible, so let's work towards a Friday July 25 deadline.

I propose this week we go in the following order to prevent us working on overlapping drafts
Judy goes through the draft tonight
Steve has another look tomorrow.
Then Roy, then John, then me.

On Tue, Jul 15, 2025 at 3:47 PM John Christy <climateman60@gmail.com> wrote:

I like Judy's idea. It's one way to avoid going through the preparation and experience of something like a colonoscopy twice in one month.

John C.

On Tue, Jul 15, 2025 at 2:12 PM Judith Curry <curry.judith@gmail.com> wrote:

Here is a way around the NCA4 issue, propose adding the following text to end of section 8.3

NCA4 provided a better assessment than NCA5 in terms of a more thorough consideration climate science, use of data back to 1901, and less of an advocacy tone. However, NCA4 shared the following endemic problems with NCA5

- Overconfidence in conclusions
- Inadequate treatment of natural variability
- Inadequate Traceable Accounts and communication of uncertainty
- Over reliance on extreme scenarios

On Tue, Jul 15, 2025 at 12:02 PM Steven Koonin <steven.koonin@gmail.com> wrote:

Just a heads up that I will be on the West Coast with very limited connectivity from tomorrow (Wednesday) evening through Monday evening (West Coast times). Back on the East Coast early Tuesday morning.

SEK

From: Travis Fisher <travis.scott.fisher@gmail.com>

Sent: Tuesday, July 15, 2025 1:47 PM

To: Steven Koonin <steven.koonin@gmail.com>

Cc: Judith Curry <curry.judith@gmail.com>; Ross McKittrick <ross.mckittrick@gmail.com>; John Christy <climateman60@gmail.com>; Roy W. Spencer <roywspencer@hotmail.com>; Josh Loucks <loucksj14@gmail.com>; Seth Cohen <seth.cohen@hq.doe.gov>

Subject: Re: NCA5 progress

Hi all,

If we need to move quickly to publish the NCA critique as a DOE product, what would be a reasonable date for us to consider it final from the authors' point of view (subject to internal review for errors but not subject to political meddling)? I have to build a publication schedule, and I'd like to work backward from a date that's comfortable for you all.

I ask because the political powers that be are interested in having a published version to cite. Sooner is better, of course, but I don't want to jam you up. They certainly want it to be published before we could conceivably have a new head of the USGCRP, so it will have to be a DOE report.

Finally, if you're considering critiquing the entire NCA apparatus and previous reports, I think that would be helpful. The political response to an NCA5 critique so far has been (I'm paraphrasing), "Even if we show that NCA5 is not a solid basis for policymaking, what about NCA4 and prior reports?"

As always, please feel free to call me or convene a meeting if you want to discuss anything. I'll also try to keep everyone posted as the CWG report moves through the necessary hoops.

Best,
Travis

On Tue, Jul 15, 2025 at 11:41 AM Steven Koonin <steven.koonin@gmail.com> wrote:

I've marked up Judy's "desnarked" version (attached). Mostly typos and wording, but a few issues of substance. And still on the fence about whether and how to include the NCA4 story on temperature extremes.

SEK

From: Judith Curry <curry.judith@gmail.com>

Sent: Sunday, July 13, 2025 3:12 PM

To: Ross McKittrick <ross.mckittrick@gmail.com>

Cc: Steven Koonin <steven.koonin@gmail.com>; John Christy <climateman60@gmail.com>; Roy W. Spencer <roywspencer@hotmail.com>; Travis Fisher <travis.scott.fisher@gmail.com>; Josh Loucks <loucksj14@gmail.com>; Seth Cohen <seth.cohen@hq.doe.gov>

Subject: Re: NCA5 progress

see attached for a shorter, desnarked version of NCA5 for you to consider. I didn't do track changes, its clean text

On Sun, Jul 13, 2025 at 10:55 AM Ross McKittrick <ross.mckittrick@gmail.com> wrote:

Steve- this is the most recent version I have. There is also a Supplement on precip trends.

On Sat, Jul 12, 2025 at 6:18 PM Steven Koonin <steven.koonin@gmail.com> wrote:

Ross- Can you send around the most recent version of the NCA5 review. I can't seem to identify it in the emails and would like to go through it again in the next few days.

SEK

From: Ross McKittrick <ross.mckittrick@gmail.com>

Sent: Friday, July 11, 2025 3:49 PM

To: John Christy <climateman60@gmail.com>

Cc: judith curry <curry.judith@gmail.com>; Roy W. Spencer <roywspencer@hotmail.com>; Steven Koonin <steven.koonin@gmail.com>; Travis Fisher <travis.scott.fisher@gmail.com>; Josh Loucks

<loucksj14@gmail.com>; Seth Cohen <seth.cohen@hq.doe.gov>

Subject: Re: NCA5 progress

John and I only appear in Section 4.1 as part of challenging the reproducibility of the NCA5 Key Message regarding precipitation. 2 of our 3 citations in the reference list are data archives which are there for transparency purposes.

On Fri, Jul 11, 2025 at 2:53 PM John Christy <climateman60@gmail.com> wrote:

Judy

I must be missing something. Our papers directly address the issues espoused by NCA5. We offer all the data and methods. Why should our work be suppressed?

John C.

Sent from my iPhone

On Jul 11, 2025, at 1:16 PM, judith curry <curry.judith@gmail.com> wrote:

We need to think about our audience who we want to reach and influence. We don't want this to be another salvo in the climate wars. But to rise above it and be hyper objective.

Sent from my iPhone

On Jul 11, 2025, at 10:07 AM, John Christy <climateman60@gmail.com> wrote:

Judy

... Christy, McKittrick and Koonin ... you could look at it this way: we're the only ones willing to stick our heads up when the bullets are flying and endure protracted battles with editors and reviewers. Publishing in journals in this "climate" takes its toll, and most folks with an objective side just give up. We would love to cite other authors who do these NCA5-type analyses using the proper methods ... there just aren't many out there. As you know, there's no profit (or funding) in fighting the climate establishment. However, please, let us know if you see something we've missed.

John C.

On Fri, Jul 11, 2025 at 11:21 AM Judith Curry <curry.judith@gmail.com> wrote:

Re 1.4 and TX, i suggest we incorporate these points briefly in existing chapters. The content of 1.4 is already covered in CWG, apart from the convoluted peer review issue. CWG adequately covers temperature extremes, we don't need more of that in NCA beyond length of temperature records. Re TX, might fit best in CWG attribution, but its too early for that I think.

In 8.3 Recommendations for NCA5, we should recommend an increased focus on predicting individual extreme events and communicating the forecast, rather than attributing them to whatever.

What i'm struggling with in the NCA5 critique is that if you read it without an author list, you would figure the authors are christy, mckitrick, koonin. This should be a relatively short, high-level critique and IMO we need to depersonalize this

On Fri, Jul 11, 2025 at 8:19 AM Ross McKitrick
<ross.mckitrick@gmail.com> wrote:

We seem to have stalled on iterating the NCA5 report. Here are the issues on the table:

1. Whether to drop Section 1.4

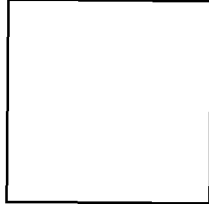
- my thinking is I like the idea of the section because it justifies why we would presume to critique a report that has already gone through 11 government agencies and a National Academies review. At the same time I think it could be shortened and made more effective with a different version of the Figure from CWG25. John if you can you send me the spreadsheet you used I'll propose a rewrite.

2. Do we include a case study of the Texas floods?

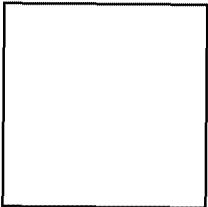
- What I like about that section is that it is a vivid example of how a document that could have provided useful info for disaster planners not only failed to do so, but it would have misdirected resources if they were to have relied on it. But it's easy to have 20/20 hindsight. Presumably somewhere in the US at this moment there are several potential weather-related hazards poised to cause death and destruction later this year, and the local authorities are not ready for them. We need to explain what it would look like for an NCA to be a useful resource in that context. What say ye all?

3. Tidying

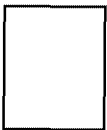
- I find the LLM critiques to be somewhat helpful in anticipating possible lines of attack, but they are overly algorithmic and often end up saying "they make a valid point but that's not the consensus so it's probably wrong." And it seems to have hallucinated about things we didn't even say. Still, it points to the need to guard against snark.



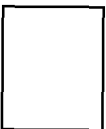
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Critique of the Fifth National Climate Assessment

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EXECUTIVE SUMMARY

This report critically evaluates the Fifth National Climate Assessment (NCA5), finding it an inadequate basis for climate and energy policies. A detailed review of the foundational chapters on climate science raises several key concerns:

Scientific Integrity

- An advocacy tone, particularly in the Overview chapter, that is inconsistent with scientific objectivity
- Framing climate policy as a morality play
- Endemic overconfidence when stating conclusions, including inflated certainty levels and overstatement of findings from underlying sources
- No mentions of dissent, disagreement, controversies, or tradeoffs

Flawed methodology

- Minimal discussion of observational inadequacies
- Use of short time periods for trend analyses; lack of a consistent rationale for choosing time scales
- Attribution is implied, not dissected
- Overemphasis on extreme scenarios for future emissions and sea level rise
- Inadequate traceable accounts to support key conclusions

Inadequate Review Process

- A review by the National Academy of Sciences, Engineering, and Medicine (NASEM) failed to identify some fundamental flaws in NCA5
- The NCA5 authors failed to adopt some improvements recommended by NASEM

The report shows NCA5 to be a biased and incomplete picture of climate science that skews toward excessive climate risk. Consequently, NCA5 should not be used as basis for climate and energy policies.

1 INTRODUCTION

1.1 About this Report

This report responds to a request from the Office of Science and Technology Policy (OSTP) Director Michael Kratsios (reproduced in the Appendix) [MAY HAVE TO MODIFY THIS] that we assess the suitability of the Fifth National Climate Assessment (NCA5 2023) for informing climate and energy policies.

To conduct this assessment, we reviewed NCA5 itself, the National Academies of Science, Engineering and Medicine (NASEM) review of the Third Order NCA5 Draft, and the USGCRP responses to that review. We have drawn upon our long experience working on advisory reports, including for the NASEM, the Intergovernmental Panel on Climate Change (IPCC), and other organizations as writers, reviewers, and study leaders. Further, we have reviewed recent scientific developments in a separate report to Energy Secretary Wright (Climate Working Group 2025, herein denoted “CWG25”).

We find that NCA5 should not be relied on for policy making as it portrays an incomplete and misleading picture of our understanding of the changing climate and the risks it poses to the nation. NCA5 was selective and incomplete in its survey of climate science. The overall effect of the biases and omissions of NCA5 is an excessively dire picture of climate risk.

To support our finding, the following sections of this chapter provide some background on the National Climate Assessments and the standards by which we have assessed NCA5. Chapters 2 through 7 detail important ways in which NCA5 fails to meet those standards. Finally, Chapter 8 summarizes our evaluation of NCA5 and makes recommendations for NCA6.

1.2 About the National Climate Assessments

The U.S. Global Change Research Program (USGCRP) was established by Presidential Initiative in 1989 and mandated by Congress in the Global Change Research Act (GCRA) of 1990 to develop and coordinate “a comprehensive and integrated United States research program which will assist the Nation and the world to understand, assess, predict, and respond to human-induced and natural processes of global change.”

The National Climate Assessment (NCA) Reports evolved from the GCRA requirement to:

Prepare and submit to the President and the Congress an assessment which (1) integrates, evaluates, and interprets the findings of the Program and discusses the scientific uncertainties associated with such findings; (2) analyzes the effects of global change on the natural environment, agriculture, energy production and use, land and water resources, transportation, human health and welfare, human social systems, and biological diversity; and (3) analyzes current trends in global change, both human-induced and natural, and projects major trends for the subsequent 25 to 100 years.

The five NCA Reports to date have interpreted this mandate in different ways:

- NCA1 (2000) was a multidisciplinary effort to study and portray in regional detail the potential effects of human-induced global warming on the United States.

- NCA2 (2009) was a relatively short report that not only focused on the potential consequences of climate change but also sought to identify potential adaptation measures and identify the highest priorities for future research.
- NCA3 (2014) was an expanded effort that continued along the lines of NCA2, and was distinguished by a comprehensive review process, including a review by the National Academy of Sciences. NCA3 introduced a traceability analysis for each key finding, including a description of uncertainties.
- NCA4 (2017/2018) was a further expanded effort that was published in two volumes: I Climate Science Special Report (CSSR), and II Impacts, Risk, and Adaptation in the United States. This was the first NCA report to devote significant effort to assessing climate science.
- NCA5 (2023) returned to a single volume format, reducing discussion of climate science to a cursory two chapters, with continuing focus on regional and sectoral impacts of climate change. NCA5 expanded its remit to topics that are arguably outside the purview of the USGCRP, focusing on “Climate Action” and policy recommendations with a social justice emphasis.

These successive interpretations of the NCA are poorly aligned with the GCRA’s statutory requirements. Only NCA4 gives serious consideration to climate science, which receives the great majority of USGCRP funding, and even then NCA4 misrepresents some important points. Natural climate variability is essentially dismissed as unimportant in NCA4 and barely mentioned in NCA5 in most contexts, despite the mandate to include both human-caused and natural climate change. Most significantly, NCA5 has redirected the focus away from climate science and even the hazard elements of impacts, towards evaluation of societal vulnerabilities and advocacy for particular policy options, especially deployment of wind and solar power generation.

1.3 Standards for Assessing NCA Products

Beyond the statutory requirements stated above, another pertinent standard is President Trump’s executive order of May 23, 2025, Restoring Gold Standard Science. It enumerates some of the characteristics of good science, namely that it should be:

- i. reproducible;
- ii. transparent;
- iii. communicative of error and uncertainty;
- iv. collaborative and interdisciplinary;
- v. skeptical of its findings and assumptions;
- vi. structured for falsifiability of hypotheses;
- vii. subject to unbiased peer review;
- viii. accepting of negative results as positive outcomes; and
- ix. without conflicts of interest.

For an assessment of policy relevant science, it is also important to include statements about the strength of knowledge. The IPCC’s approach to assessing strength of knowledge is based on judgment of the available evidence and agreement among experts. But there are more sophisticated knowledge characterizations for risk management. Here are the elements according to Aven (2017):

- The degree to which the assumptions made are reasonable/realistic based on background knowledge

- The degree to which data/information exists and are reliable and relevant
- The degree to which there is disagreement among experts (including those from different environments or academic fields)
- The degree to which the phenomena involved are understood and accurate models exist
- The degree to which the knowledge has been thoroughly examined with respect to unknown knowns (issues that are known to matter but are ignored, such as, in this context, natural variability).

2 NCA5 OVERVIEW CHAPTER: ADVOCACY LANGUAGE AND UNSCIENTIFIC TONE

NCA5 Chapter 1, “Overview”, holds a prominent place in the Report since it summarizes the entire report and is the only section that many will read. Chapter 1 is marred by an activist tone, language that aggressively promotes mitigation policies, and motivated optimism. As such, this chapter adds an imprimatur of scientific authority to naïve and simplistic declarations of opinion about public policy. Here are some examples.

Chapter 1 opens with:

The more the planet warms, the greater the impacts. Without rapid and deep reductions in global greenhouse gas emissions from human activities, the risks of accelerating sea level rise, intensifying extreme weather, and other harmful climate impacts will continue to grow. Each additional increment of warming is expected to lead to more damage and greater economic losses compared to previous increments of warming, while the risk of catastrophic or unforeseen consequences also increases.

This statement presupposes that all warming is anthropogenic, that all warming is bad and causes economic damage, and that warming intensifies extreme weather. Such sweeping generalizations go well beyond what science has or can establish. The statement also refers to growing risks without reference to their magnitude – a small risk that increases might still be a small risk, and a large risk might be only incrementally worsened.

On the next page one finds:

Each additional increment of warming leads to greater risks [here it lists 7 key components of society including food security and the economy] ... Without deeper cuts in global net emissions, climate risks to the US will continue to grow... Action to limit future warming and reduce risks can have near-term benefits and opportunities: low-carbon energy jobs, Improved air quality, Health benefits, Economic benefits...”

The authors write as if climate policy does not involve trade-offs and all measures to reduce future warming will be effective and beneficial. Neither the vast body of scholarship on climate science and economics nor historical experience support such simplistic claims (CWG25). Not every additional increment of warming leads to economic harms; in fact, NCA5 Chapter 19 acknowledges that there will also be benefits. Nor is climate policy guaranteed to benefit the economy; it could impose net costs. Such misleading statements are a disservice to policymakers.

Pages 8 and 9 of the Overview promote renewable energy options by noting, correctly, that the levelized costs of wind/solar generation have fallen sharply since 2010, and so offers this rationale for pursuing deep emission reductions:

Recent growth in the capacities of wind, solar, and battery storage technologies is supported by rapidly falling costs of zero- and low-carbon energy technologies, which can support even deeper emissions reductions. For example, wind and solar energy costs dropped 70% and 90%, respectively, over the last decade, while 80% of new generation capacity in 2020 came from renewable sources.

Yet it has long been known that intermittent renewables generation must be supplemented by dispatchable generation to meet grid reliability standards, and that doing so (*e.g.*, through natural gas, fission, or storage) significantly increases the total cost of electricity. Further, there are yet unmet synchronization challenges in electrical grids with heavy penetration of wind and solar generation. NCA5 fails to acknowledge these facts. But more importantly, we see no reason for NCA5 to be discussing renewable energy technologies and economics in the context of its mandate.

Page 17 of the Overview introduces the discussion of risks from extreme weather events by saying “Harmful impacts from more frequent and severe extremes are increasing across the country.” This creates the impression that extreme weather events are worsening and that disaster losses are driven by trends in extreme weather. While the section goes on to acknowledge that some of the increase is due to increases in the exposure and value of assets at risk, it then invokes the NOAA Billion Dollar Dataset as evidence of extreme weather getting worse. Scientists have shown that this is an invalid metric (CWG25 Section 10.2) since it measures the growth of vulnerable infrastructure, not the frequency of extreme weather, and indeed NOAA has recently withdrawn the data product. Even though the dataset was still distributed by NOAA at the time of the NCA5, the report authors failed to assess it skeptically and see that it was unfit for the purpose of measuring climate trends.

Page 23 of the Overview states, in large font:

Climate changes are making it harder to maintain safe homes and healthy families; reliable public services; a sustainable economy; thriving ecosystems, cultures, and traditions; and strong communities.

This statement cannot be evaluated on scholarly grounds and so doesn’t belong in a scientific assessment report. Its prominent inclusion points not only to the willingness of NCA5 authors to promote alarm, but also the ineffectiveness of the review process in eliminating such statements.

3 OVERCONFIDENCE WHEN STATING CONCLUSIONS

3.1 Inflated certainty levels

Overconfidence in stating conclusions has been an endemic problem in NCA Reports. The authors frequently make sweeping generalizations without appropriate caveats or acknowledging uncertainties. The overconfidence begins with inflated language to describe certainty levels.

NCA5 uses specific terms to convey information about scientific confidence associated with important findings, observations and projections. The Front Matter of NCA5 states that

confidence in a finding is based on the type, amount, quality, strength, and consistency of evidence; the skill, range, and consistency of methods to detect, evaluate, attribute, and interpret climate trends; and the degree of agreement across scientific information sources.

Table 1 from the Front Matter provides calibrated language for confidence assessments:

Very high:	Strong evidence (established theory, multiple sources, well documented and accepted methods, etc.). High consensus
High:	Moderate evidence (several sources, some consistency, methods vary and/or documentation limited, etc.). Medium consensus
Medium:	Suggestive evidence (a few sources, limited consistency, methods emerging, etc.) Competing schools of thought.
Low:	Inconclusive evidence (limited sources, extrapolations, inconsistent findings, poor documentation and/or methods not tested, etc.). Disagreement or lack of opinions among experts.

This terminology is obviously inflated: *high confidence* with just moderate evidence and medium consensus; *medium confidence* with only suggestive evidence and competing schools of thought. This inflation in terminology leads to overconfidence in conclusions.

Even with this inflated terminology, NCA5 further inflates the confidence level of many of its conclusions to well beyond what the IPCC has concluded with more thorough justification, and by incorrectly applying its own standards. An example is the conclusion about anthropogenic influence on climate change, arguably one of the most important scientific statements of the report.

Key Message 3.1 Traceable Account states:

There is *very high confidence* that emissions of GHGs from human activities, fossil fuel use in particular, have unequivocally caused *all* global warming observed over the industrial era.

while the corresponding statements from IPCC AR5 and AR6 are

AR5: It is *extremely likely* that *more than half* of the observed increase in global average surface temperature from 1951 to 2010 was caused by the anthropogenic increase in greenhouse gas concentrations and other anthropogenic forcings together. (IPCC, 2013)

AR6: The *likely* range of total human-caused global surface temperature increase from 1850–1900 to 2010–2019 is 0.8°C to 1.3°C, with a best estimate of 1.07°C. It is *likely* that well-mixed GHGs contributed a warming of 1.0°C to 2.0°C, other human drivers (principally aerosols) contributed a cooling of 0.0°C to 0.8°C, natural drivers changed global surface temperature by –0.1°C to +0.1°C, and internal variability changed it by –0.2°C to +0.2°C. It is *very likely* that well-mixed GHGs were the main driver of tropospheric warming since 1979.

The IPCC AR5 and AR6 statements provide likelihood assessments but not a confidence level. While NCA5 claims with *very high confidence* that fossil fuels have unequivocally caused *all* global warming, AR5 refers to “*more than half* of the observed warming” and AR6 provides a more nuanced statement that relates to a *likely* range of warming contributed to by human drivers.

3.2 Overstating findings in underlying sources

Although we did not do a detailed audit of NCA5's use of source material, spot checks suggest a pattern of overstatement.

Chapter 2 page 11 reports on an increase in precipitation in some areas and attributes it to "climate change":

Many eastern regions of the country are getting wetter (Figure 2.4). Average annual precipitation from 2002-2021 was 5%-15% higher relative to the 1901-1960 average in the central and eastern US, a trend attributable to climate change.

NCA5 attributes the claim to Knutson and Zeng (2018). But Knutson and Zeng did not say these things nor did they analyze this particular period. For 1981-2010 they cautioned that observed changes are consistent with natural variability, and they did not claim attributable trends were observed over the United States.

As another example of overstating findings, NCA5's Chapter 2 page 18 states

There is robust evidence that human-caused warming has contributed to increases in the frequency and severity of the heaviest precipitation events across nearly 70% of the US.

This is apparently attributed to Diffenbaugh *et al.* (2018) and Kirchmeier-Young and Zhang (2020). Diffenbaugh *et al.* presented ratios of observed occurrences of extreme events to simulated occurrence rates in CMIP6 models run with only natural forcings. They report that for 79% of the U.S., extreme rainfall events are currently more frequent than in simulations, and the ratio of occurrences will rise under future warming simulations. This is not "robust" evidence of anthropogenic influence since it requires readers to assume that climate models accurately simulate regional precipitation patterns, something that the IPCC AR6 states is uncertain (AR6 WGI SPM Box SPM 1.2, SPM Section C.1.3).

Kirchmeier-Young and Zhang used three global climate models to analyze extreme 1- and 5-day events in North America. They noted large differences among the three models in their simulated precipitation changes, and two of the three models failed to yield attribution for 5-day events for the North America mean. [DON'T UNDERSTAND THIS PHRASE] THIS IS CLEAR, KEEP AS IS MIGHT MAKE SENSE TO ME IF WORDED AS "for the North American mean of 5-day events." In other words, the models disagreed on whether the observed changes were anthropogenic. Both of the cited references utilized the implausible RCP8.5 scenario (Chapter 6 of this report) and began their historical observational records only in 1961. Here again this is not "robust" evidence. It is merely suggestive, particularly since other studies have found natural variability to be predominant.

3.3 Example: Emergent constraints

Some of the overconfidence expressed by NCA5 arises by omitting discussion of counterevidence in the peer reviewed literature, ignoring dissent and disagreement. An example is the topic of "emergent constraints". NCA5 Chapter 3 page 17 invokes this concept to support its claim that key uncertainties in climate model projections have been reduced:

An approach to reduce uncertainty in climate change projections has matured over the past decade. It is known as "emergent constraints." The term refers to strong statistical relationships between highly uncertain future climate parameters and observable trends or variations in the current climate, along with a physical explanation of this relationship.

Emergent constraints appeared in the climate modeling literature as an attempt to tie climate model behavior to climate observations in hopes of generating insight into real-world equilibrium climate sensitivity (ECS). Climate models exhibit a wide range of ECS values. The idea of emergent constraints is to examine whether the models with shared sensitivity values also share a common representation of some climate process (usually related to clouds) that might influence ECS. Suppose, for example, that in low-ECS models the total cloud fraction in the tropics is strongly correlated with that in the southern midlatitudes, but in high-ECS models the correlation is weak. Then researchers could examine whether the observed correlation is strong or weak and draw a conclusion about which type of model, and therefore which ECS value, is more likely.

A problem in the emergent constraint literature is that there has been a proliferation of proposed correlations with little physical motivation. NCA5 alludes to this in the Traceable Accounts section (p. 3-40) but not in the main chapter text. As shown by Schlund *et al.* (2020), many emergent constraints patterned on CMIP5 models (Coupled Model Intercomparison Project Phase 5, used for the IPCC 5th Assessment Report) failed to work on CMIP6 models (used for the IPCC 6th Assessment Report). In other words, the correlations between ECS and cloud processes present in CMIP5 models were absent in CMIP6 models, indicating that they were likely spurious rather than clues to physical processes governing the climate system. As a result, emergent constraints estimated on CMIP5 models *increased* the uncertainty of ECS, rather than decreasing it as claimed by NCA5.

Yet NCA5 described the use of emergent constraint analysis as an advance that reduced the uncertainty of ECS and climate model projections (p. 3-38):

Emergent constraints have been widely applied to reduce the simulated spread in the climate feedbacks that shape climate sensitivity.

4 ARBITRARY AND AMBIGUOUS TREND ANALYSES

CWG25 Chapter 6 discussed the need for care in the choice of time scale when making claims about trends in extreme weather. We provided examples from analysis of river flooding, heatwaves, and extreme precipitation to show how assertions about apparent trends based on short data sets fall apart when considering longer versions of the same data sets. NCA5 uses varying time periods for trend analyses, especially in Chapter 2 (which is focused on trends), without explaining why shorter or longer intervals were chosen. For example, page 2-4 defines temperature trends over the interval since the late 1800s whereas page 3-29 presents temperature trends over 1972-2021. Page 2-11 compares rainfall over the 2002-21 versus 1901-1960 intervals, while page 2-18 uses the interval since the late 1950s to compute trends.

A further problem is that NCA5 uses the term "trend" repeatedly without indicating if it is statistically significant (*i.e.*, distinguishable from random variability); the ambiguity creates the impression all the observed changes were significant, but readers are left to speculate. All climate variables will, in principle, drift up or down over any particular time interval. Identifying the change as a trend requires showing that it is statistically significant using a variance estimator suitable for the type of

data being analysed. Of particular importance is choosing a method robust to the serial correlation that is frequently present in climate data. Throughout Chapters 1 to 3, references are made to “trends” without explaining how they were computed. The exception was on page 1-19 which refers to urban temperature trends being calculated using the Theil-Sen estimator, although that method does not seem to have been used elsewhere. The one case where reference is made to statistical significance is on Page 2-9, referring to a trend in Atmospheric Optical Depth, but there is no explanation of how significance was determined. Page 2-19 refers to regional trends in droughts being “robust” but again fails to explain how the term was defined.

4.1 Average and Extreme Precipitation

In CWG25 Section 6.4 we presented analyses of updated data for the same locations [SAME AS WHAT?] (and many others), in all cases finding both considerable regional heterogeneity and that trends detectable on one time scale are often not detected on longer or shorter time scales. These findings argue against simple attribution of changes to anthropogenic influences. In this section, when we refer to calculation of trends in precipitation, we use ordinary least squares to compute the linear trend over the entire sample length and we use the Vogelsang and Franses (2007) variance estimator which is robust to general forms of serial correlation. IS THIS STATEMENT NEEDED?

NCA5 did not continue the NCA4 precedent of using the post-1901 interval as the time scale for its precipitation discussion. Instead, it refers to changes “since the 1950s”; NCA5 Figure 2.8 suggests 1958 might be the intended start date. Under Key Message 2.2, “Extreme Events Are Becoming More Frequent and Severe”, NCA5 states (p. 2-18):

Rainfall is becoming more extreme
Since the 1950s, there has been an upward trend in heavy precipitation across the contiguous US. This increase is driven largely by more frequent precipitation extremes, with relatively smaller changes in their intensity.

In addition to our concerns that inferences about trends are contingent on choice of time scale, if the intended meaning of this statement is that positive and significant trends are found in heavy precipitation events across CONUS, we cannot reproduce it. Details of our analysis can be found at LINK TO BRIEF WRITEUP ON THIS can we just reference CWG HERE

Based upon our analysis, the following is a more accurate summary of what U.S. precipitation data show.

There are regionally heterogeneous changes in average and extreme precipitation. Positive trends in annual average rainfall and extreme events (defined either as the annual maximum or the number of exceedances of the 99th percentile value) are generally weak or non-existent when looking at samples exceeding 130 years in length. Significant trends can be found when beginning the sample in the 1950s although in most cases the trends weaken and become insignificant when looking at the post-1980 interval. This argues against attribution of changes in precipitation to anthropogenic warming.

4.2 Heatwaves

In contrast to NCA5, NCA4 examined heat extremes across the entire 20th century, pointing out that peak heat wave activity was reached in the 1930s and has decreased since then, and that recent increases are confined to areas west of the Rockies. NCA4 stated:

[The] warmest daily temperature of the year increased in some parts of the West over the past century, but there were decreases in almost all locations east of the Rocky Mountains. In fact, all eastern regions experienced a net decrease, most notably the Midwest (about 2.2°F [1.2°C]) and the Southeast (roughly 1.5°F [0.8°C]).

Since the mid-1960s, there has been only a very slight increase in the warmest daily temperature of the year (amidst large interannual variability). Heat waves (6-day periods with a maximum temperature above the 90th percentile for 1961–1990) increased in frequency until the mid-1930s, became considerably less common through the mid-1960s, and increased in frequency again thereafter. As with warm daily temperatures, heat wave magnitude reached a maximum in the 1930s. (NCA4 pp. 190-191)

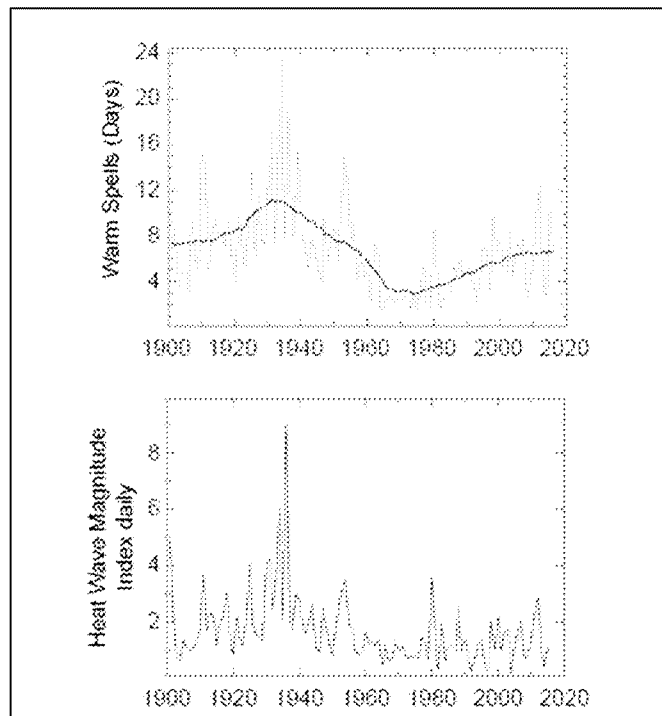


FIGURE 3. U.S. Heat waves since 1900. Reproduction of NCA4 Figure 6.4

Contrast this careful and factual language from NCA4 with NCA5 Key Message 2.2: “Extreme Events Are Becoming More Frequent and Severe.” This blanket statement is followed by NCA5 Figure 2.7 (reproduced as Figure 4 below) which shows the number of hot days, cold days and warm nights (respectively in panels a—c) over the period 2002-2021 compared to 1901-1960. [Presumably these are annual counts, although not stated in the caption.]

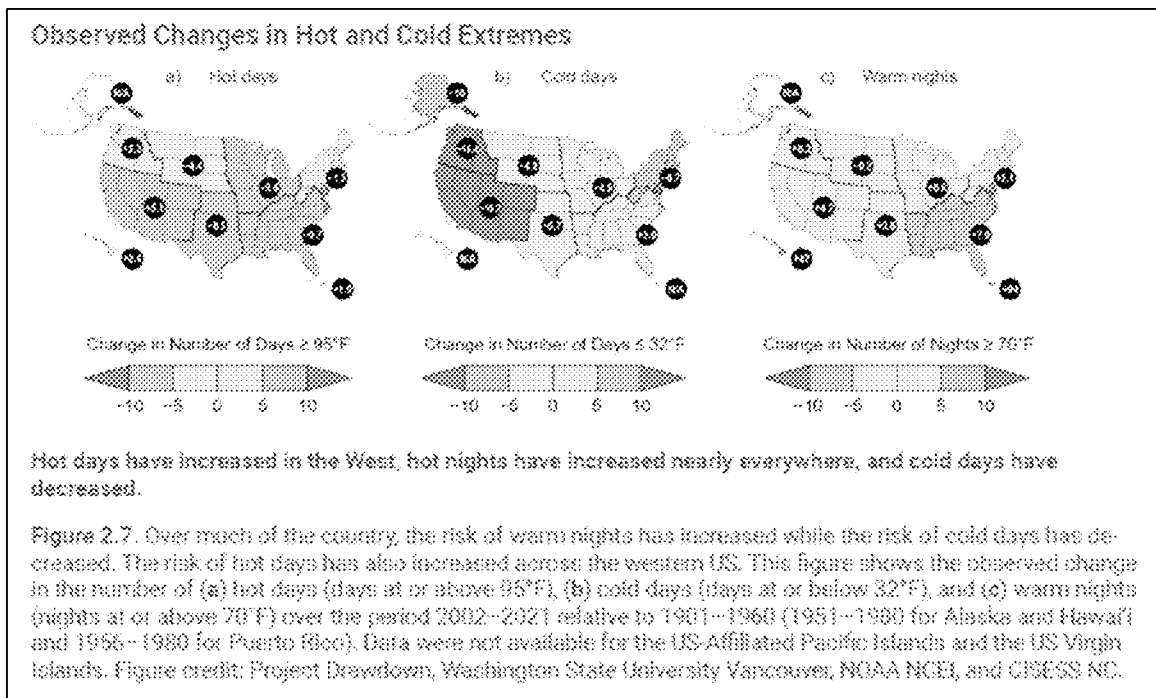


FIGURE 4: Reproduction of NCA5 Figure 2.7.

Close inspection shows that this figure actually contradicts the NCA5 Key Message with respect to heatwaves and instead reinforces the position of NCA4. Notwithstanding Key Message 2.2, the leftmost panel in NCA5 Figure 2.7 above shows that over most of CONUS the number of extreme heat days has *decreased* in recent decades compared to the prior century.

The accompanying discussion in NCA5 becomes convoluted as it appears to be aimed at supporting the Key Message despite the contrary evidence. NCA5 Chapter 2 elaborates on Key Message 2.2 by stating (page 2-16):

Observations show an increase in the severity, extent, and/or frequency of multiple types of extreme events. Heatwaves have become more common and severe in the West since the 1980s (*high confidence*).

But while it mentions the increase in hot days in the West, it fails to mention the decrease everywhere east of the Rockies. On the next page (page 2-17) it raises the comparison to the 1930s and then switches to discussing global counts:

By some measures, the most extreme heatwaves on record in the United States occurred during the Dust Bowl era of the 1930s. ... Globally such heatwaves are becoming more frequent, and in recent decades the western United States has been following those trends.

The reference to a global trend seems to be an attempt to tie heatwaves to anthropogenic climate change. But the obvious question, unaddressed by NCA5, is why one region follows the global pattern of increasing heatwaves while most of the country is trending in the opposite direction. These issues are addressed in Chapter 6 of CWG25, demonstrating that the range and magnitude of extreme temperatures are driven more by natural variability than by anthropogenic forcing. The analysis in CWG25 shows that for both (a) hot days ($\geq 95^{\circ}\text{F}$) and (b) number of days in heatwaves, the current decade is no hotter than a century ago in the U.S. Thus, the NCA5 claim that “multiday heatwaves

have become hotter, more frequent, larger, and longer lasting in recent decades,” is simply false when expanding the temporal and spatial domains to encompass all available data (Chapter 6 and Figure 6.3.6 of CWG25).

NCA5 then pointed to the dramatic Pacific Northwest heatwave of 2021. CWG25 Section 8.6.1 discusses this event in detail, reviewing the multiple peer reviewed studies that explained the unusual meteorological context was unrelated to human-caused climate change, a point omitted from the NCA5 discussion.

NCA5 finally addresses the declining heatwave trend in CONUS east of the Rockies but attempts to reframe it by focusing on urban warm spells.

[The] number of very hot days has actually decreased across the central and eastern regions due to summer cooling trends in the region (Figure 2.7; Ch. 22). This does not, however, mean the central and eastern US are not affected by heat. The impacts of extreme high temperatures are more severe if such conditions persist for several days, and overall, multiday heatwaves have become hotter, more frequent, larger, and longer lasting in recent decades. Across 50 large US cities, the US Global Change Research Program heatwave indicator (<https://www.globalchange.gov/indicators/heat-waves>) shows that the average number of heatwaves has doubled since the 1980s, and the length of the heatwave season has increased from about 40 days to about 70 days.

We discussed this part of NCA5 in CWG25 Section 6.3. The figure referenced by NCA5 uses a short time period which begins in the 1960s, the coldest decade in the last 100 years, thus suppressing any comparison to the 1930s. Further, nighttime temperatures in urban areas have increased faster than daytime temperatures (which NCA5 acknowledges), but this is a signature of urban heat islands and not a good metric of climate change. CWG25 found that the occurrence of hot days ($\geq 95^{\circ}$ F) has recently increased in the West, but declined since 1899 in the remainder of the country and in the nationwide average.

5 INADEQUATE TRACEABLE ACCOUNTS

NCA3 began the practice of including a section on Traceable Accounts at the end of each chapter. This is the description from NCA5:

Each chapter concludes with a section entitled Traceable Accounts, which provides information on the overall process used to develop the chapter as well as a separate Traceable Account section for each Key Message. These Traceable Accounts describe the supporting evidence behind each Key Message, the process and rationale authors used in reaching their conclusions, and the author team’s expert assessment of the confidence in and, where applicable, likelihood of these conclusions. As such, Traceable Accounts provide information about the state of the science, document sources of uncertainty, identify research gaps, and allow traceability to data and resources.

The Traceable Accounts for each Key Message includes the following sections:

- Description of Evidence Base
- Major Uncertainties and Research Gaps

- Description of Confidence and Likelihood

The Traceable Accounts could have addressed the statutory requirement that the NCA discuss scientific uncertainties. They could also help satisfy the Executive Order for Restoring Gold Standard Science by addressing reproducibility, transparency, communication of error and uncertainty, and skepticism of findings and assumptions. However, the Traceable Accounts in NCA5's Chapters 2 and 3 are uneven, often superficial and uninformative.

An example of a deficient Traceable Account is NCA5's Key Message 2.2: "Extreme Events are Becoming More Frequent and Severe". The "Description of the Evidence Base" offers two paragraphs, the first summarizing the findings and the second generically describing the types of data that can be used for storms. "Major Uncertainties and Research Gaps" focuses on the uneven distribution across U.S. populations due to differences in exposure and vulnerability. The only limitations in data referred to are the lack of a long-term record of lightning and the lack of homogenized daily and hourly temperature data apart from reanalysis products.

But the most astonishing deficiency is in the "Description of Confidence and Likelihood." One of the statements in Key Message 2.2 is:

Hurricanes have been intensifying more rapidly since the 1980s (*high confidence*) and causing heavier rainfall and higher storm surges (*high confidence*).

The Description of Confidence and Likelihood includes the following statement:

Basic physical understanding and climate models both provide robust explanations for the links between climate change and observed changes in these extremes: this is why the authors also have high confidence that storms are delivering more rainfall and high confidence that storm surges are becoming higher.

No reference to journal publications or a specific data set is made anywhere in the chapter regarding hurricane-induced precipitation or storm surge to support this *high confidence* conclusion.

The Traceable Accounts for the various Key Findings of Chapter 3 have some substantial inconsistencies. Consider

Key Message 3-1: Human activities have caused global warming.

Confidence and Likelihood: "There is *very high confidence* that emissions of GHGs from human activities, fossil fuel use in particular, have *unequivocally* caused all global warming observed over the industrial era. There is also *very high confidence* that changes in natural climate drivers have had globally small and regionally variable long-term effects over this period."

The Uncertainties section addresses only uncertainties in radiative forcing by greenhouse gases, ignoring the great uncertainty in model responses to that forcing (CWG25 Chapters 4 and 5) In contrast, the Traceability Analysis of Key Message 3-4 ("Humans Are Changing Earth System Processes") raises the problem that relatively little is known about the role of natural variability at the regional scale. From its Description of Evidence Base:

In the last decade, there has been increasing recognition of the role of regional-scale natural variability in the past and future evolution of climate, as well as the fact that regional natural variability signals can be competitive with forced anthropogenic signals.

And from its Major Uncertainties and Research Gaps:

For example, the true natural variability of the climate system on decadal to centennial timescales could be larger than what we estimate from GCMs, which would further increase the irreducible uncertainty stemming from natural variability.

These statements are among the most scientifically credible in the entire NCA5 and they directly undercut the confidence assigned to Key Message 3-1.

There is also a generic problem in tracing NCA5's Traceable Accounts. The Front Matter of NCA5 states:

Each figure and some tables are accompanied by a metadata survey, which can be accessed in the online version of the report by clicking on the eyeball icon above the figure or table (see the table below for explanations of additional icons used throughout the report). The metadata survey describes data sources, figure or table development methods, copyright information, and other important documentation.

Clicking on the 'eyeball' icon does not reveal the metadata information; instead a "Contact Us" email appears, addressed to the USGCRP. This is an inadequate way to archive the metadata information.

In summary, the Traceable Analyses examined here, with few exceptions, fail to meet the stated objectives of the NCA.

6 OVEREMPHASIS ON EXTREME SCENARIOS

To respond to the GCRA mandate to "project major trends for the subsequent 25 to 100 years," NCA5 relies on projections of future climate change based on estimates of future emissions (the so-called SSP scenarios) and/or specified levels of radiative forcing (the RCP scenarios). For the most part, NCA5 uses scenarios developed for the IPCC Assessment Reports.

CWG25 Section 3.2.1 presented a critical assessment of past and current IPCC scenario envelopes, showing that they have tended to overshoot observed emissions. IPCC AR6 published in 2021 stated that "The likelihood of high-emission scenarios like RCP8.5 and SSP5-8.5 is considered low in light of recent energy sector developments." and that same year UN Climate Negotiators (COP) stopped using scenarios above 4.5.

NCA5 makes the following observations about the scenarios they use:

NCA5 authors were advised to assess the full range of scenarios available. (Front Matter)

Scenarios of future emissions and land-use change are developed as plausible alternatives, but no relative likelihood is attached to them. Some recent studies, however, have argued that

the highest scenario, SSP5-8.5, is no longer plausible without a reversal of current trends in the adoption of renewables and energy efficiency. (Key Message 3.3 Traceable Analysis)

Despite acknowledging the issue, NCA5 otherwise ignored the problem. A keyword search of NCA5 of mentions of RCP/SSP scenarios finds over 50% referred to the extreme emissions scenarios RCP8.5/SSP5-8.5. Further, nine NCA5 figures (5.2, 6.9, 7.4, 11.3, 14.6, 22.13, 22.19, 27.9, 29.13) included *only* the 8.5 scenarios.

The problem of relying on extreme scenarios is particularly acute for NCA5's sea level rise projections. The sea level rise scenarios used in NCA5 do not relate directly to the SSP emissions scenarios, but rather to specified amounts of sea level rise by 2100. Table 4 of NCA5's "Guide to Using this Report" reproduced below shows that Low relates to 0.3 m (0.98 feet), Intermediate-Low relates to 0.5 m (1.64 feet), Intermediate relates to 1.0 m (3.28 feet), Intermediate-High relates to 1.5 m (4.92 feet), and High relates to 2.0 m (6.56 feet).

Table 4. Descriptive Terms for Common Sea Level Rise Scenarios Used in NCA5						
Future global mean sea level rise and sea level rise along United States coastline are shown for five scenarios in feet (and meters), relative to a 2000 baseline. The US values shown in the right half of the table are averaged across the US coastal regions, including the contiguous US, Alaska, Hawaii and the US-Affiliated Pacific Islands, and the US Caribbean. The national values shown in the table differ substantially from regional values. For example, sea level rise is higher in the Gulf Coast and lower or even negative in some parts of Alaska. In the next 30 years (2020–2050), sea level along the contiguous US coasts is expected to rise 0.92 feet (0.28 m), the same amount of sea level rise observed over the last 100 years (1920–2020). See Chapter 9 for regional sea level information. Adapted from Sweet et al. 2022.”						
Sea Level Rise Scenario Descriptor	Global Mean Sea Level			United States		
Year	2050	2100	2150	2050	2100	2150
Low	0.49 (0.15)	0.98 (0.3)	1.31 (0.4)	0.59 (0.18)	0.98 (0.3)	1.64 (0.5)
Intermediate-Low	0.66 (0.20)	1.64 (0.5)	2.62 (0.8)	0.75 (0.23)	1.64 (0.5)	2.95 (0.9)
Intermediate	0.92 (0.28)	3.28 (1.0)	6.23 (1.9)	0.89 (0.27)	3.28 (1.0)	6.89 (2.1)
Intermediate-High	1.21 (0.37)	4.92 (1.5)	8.86 (2.7)	1.12 (0.34)	4.92 (1.5)	8.86 (2.7)
High	1.41 (0.43)	6.56 (2.0)	12.14 (3.7)	1.38 (0.42)	6.56 (2.0)	12.46 (3.8)

TABLE 1: Reproduction of Table 4 from the Front Matter of NCA5

Considering only projections representing processes quantified with at least medium confidence, IPCC AR6 assessed global mean sea level projections for all emissions scenarios (including implausible extreme emissions scenarios) for 2100 to fall between 0.2 and 1.6 m (5th–95th percentile range). Nevertheless, the range of sea level rise scenarios considered by NCA5 extends to 2.0 m. Further, NCA5 fails to include plausible lower scenarios, such as 0.2 m cited by the IPCC, which also corresponds to the average rate of sea level rise over the past century.

Chapter 9 of NCA5 offers the following predictions of sea level rise:

“Under a range of potential global warming levels, average sea level along US coastlines is *likely* to be between 12 and 20 inches above 2000 sea levels in 2050 (Figure 9.2).”

The projected sea level rise values span from the Intermediate scenario to values slightly greater than the High scenario. They can be put into context by considering the observed global sea level rise from 2000-2024, which is only approximately 3.4 inches (0.28 feet). NCA5 is thus projecting a sea level rise during 2025 and 2050 that is 3.5 to 5.8 times the rate observed during 2000-2024, an exceedingly implausible outcome. Chapter 9 further states:

“Looking toward the future, an 11 inch (28 cm) average rise along the contiguous US coastline is expected by 2050 (relative to 2020), with a *likely* range of 9-13 inches.”

...

“There is *high confidence* and it is *likely* that sea levels will rise about 11 inches (likely range of about 9–13 inches) between 2020 and 2050”

In summary, NCA5 presents future sea level rise scenarios that are not directly relatable to either SSP/RCP emissions scenarios or to plausible global warming levels. The NCA5 scenarios include two that are higher than the 95th percentile for the extreme emissions scenario RCP8.5 and include hypothesized ice sheet processes in which there is low confidence. Projections to 2050 require rates of sea level rise from 2025 to 2050 that are more than triple the rate observed during 2000-2024. Further, NCA5 ascribes *high confidence* to these sea level rise projections. CWG25 Section 7.3 provides further context for USGCRP projections of extraordinary sea level rise in the next 25 years.

More generally, NCA5’s inclusion of, and even focus on, implausible extreme scenarios creates projections of alarming impacts that are very unlikely to be driven by anthropogenic warming.

7 CONFLATION OF NATURAL AND ANTHROPOGENIC CLIMATE CHANGES

NCA5’s Glossary defines “climate change” as a change in climate for any reason. This is technically correct, but at variance with the (now) popular perception of all climate changes being anthropogenic. The distinction is not academic- it is central both to attribution questions and to projections, since anthropogenic changes would respond to mitigation, while natural changes are unavoidable.

The discussion on NCA5 page 2-4 begins “Human activities are changing the climate”, then goes on to list evidence for anthropogenic GHG emissions and climate warming. The next paragraph begins “Climate change is happening now in the United States. Including Alaska, the continental US has been warming about 60% faster than the planet as a whole since 1970.” The implication is that the warming of CONUS faster than the planetary average is an effect of GHG emissions. But it is an artifact of the Earth’s surface being 70 percent ocean. Since the ocean warms more slowly than land, comparison of any land surface outside the tropics with the global average would show the land surface to be warming faster than the global average, regardless of the cause of the warming.

The same page goes on to say “Climate change is already affecting people in the United States. Extreme heat was estimated to be responsible for more than 700 deaths per year between 2004 and 2018 although some estimates put heat-related mortality closer to 1,300 deaths annually.” But extreme heat, whether natural or not, has always been a risk to human health. As to trends, the data show that adaptation has caused the mortality burden of extreme heat to drop substantially in recent decades (CWG25 Section 10.3.1).

Consider also the NCA5 statement on precipitation cited in Section 3.2:

Many eastern regions of the country are getting wetter (Figure 2.4). Average annual precipitation from 2002-2021 was 5%-15% higher relative to the 1901-1960 average in the central and eastern US, a trend attributable to climate change.

The attribution is superfluous because the statement is a tautology by NCA5's definition of climate change. But its gratuitous inclusion effectively attributes the observed trend to greenhouse gas emissions.

Exploitation of the ambiguity inherent in the term "climate change" is endemic to NCA5. The NASEM review (pp. 23-24) commented on this problem as follows:

The draft NCA5 report frequently describes "change" but does not consistently distinguish between natural variability and climate change. This lack of clarity can be misleading for the reader by creating the misconception that some impacts that are the result of the combination of natural variability and climate change are instead solely due to climate change... it is important for NCA5 authors to accurately identify the multiple drivers of change (including global change), in addition to climate change, and accurately attribute impacts. Clearly describing impacts due to natural variability, climate change, or a combination of the two is important not only for informing policy decisions, but also for building public understand [sic] and trust in the report's messages. Climate change and natural variability should be clearly defined in the glossary and natural variability could be introduced in chapter introductions when the concept is important for understanding key messages.

This could have been easily addressed, for example by reserving the term "climate change" for anthropogenic changes and using "climate variability" for natural changes. But the NCA5 authors seemingly ignored their recommendation.

A separate but related issue is use of the term "climate change" to refer to increases in socioeconomic vulnerabilities that have anthropogenic causes unrelated to GHGs. NCA5 page 1-19 states "Climate change exacerbates inequalities." But the issue discussed is the negative correlation between neighborhood-level income and land surface temperatures in urban areas. To the extent the correlation is real, the most likely explanation is that low-income households concentrate where housing is less expensive, which might be in neighborhoods with less nearby parkland and tree cover; that has nothing to do with CO₂ emissions.

8 SUMMARY EVALUATION OF NCA5 AND RECOMMENDATIONS FOR NCA6

This chapter summarizes our evaluation of NCA5 relative to OSTP's charge: whether NCA5 (1) complied with the USGCRP's statutory obligation; (2) adheres to the core tenets of Gold Standard Science; and (3) can suitably inform federal climate and energy policy. The points made in this summary analysis refer to specific sections of this report as well as to the CWG25 report.

8.1 Compliance with USGCRP's statutory obligation

As cited in Section 1.2 of this report, the Global Change Research Act requires an assessment that:

- (1) integrates, evaluates, and interprets the findings of the [Global Change Research] Program and discusses the scientific uncertainties associated with such findings;

- (2) analyzes the effects of global change on the natural environment, agriculture, energy production and use, land and water resources, transportation, human health and welfare, human social systems, and biological diversity; and
- (3) analyzes current trends in global change, both human-induced and natural, and projects major trends for the subsequent 25 to 100 years.

We deem NCA5 to have fallen short when evaluated against these criteria because of the following major shortcomings (each is detailed in the sections and chapters cited):

- Inadequate assessment of the relevant topics in climate science and the hazard components of climate impacts (such as hurricanes and floods). NCA5 instead focuses on evaluation of societal vulnerabilities (such as flood infrastructure, access to air conditioning, etc.), “Climate Action,” and policy recommendations with a social justice emphasis (Section 1.2).
- Overconfidence in conclusions and inadequate assessment of uncertainties (Section 3.1.5)
- Inadequate discrimination between natural and human-induced causes of trends and impacts (Chapter 7)
- Inadequate analyses of climate trends by relying on short time periods (Chapter 6)
- Uncritical evaluation of emission scenarios and climate model simulations in making projections for the next 25 to 100 years (Chapter 6; Section 3.2.1 and Chapter 5 of CWG25).

8.2 Adherence to the tenets of Gold Standard Science

With respect to the tenets of Gold Standard science listed in Section 1.2 of this report, we have identified the following major shortcomings in NCA5:

- **Lack of reproducibility.** In the few examples that we examined closely, we identified an instance where we could not reproduce the findings of the NCA5, a task that should require only rudimentary data analysis (Section 4.1)
- **Lack of transparency.** In many instances, the Traceable Account fails to justify the Key Finding. Metadata was not readily accessible. (Chapter 5)
- **Inadequate communication of error and uncertainty.** The Traceable Account for each Key Message provides a section on Major Uncertainties and Research Gaps; most of the accounts that we examined were superficial and uninformative. (Chapter 5)
- **Not skeptical of findings and assumptions.** The main text of the chapters is, with few exceptions, not skeptical of its findings and assumptions and does not mention dissent or disagreement. (Chapters 3 and 5)
- **Some hypotheses and Key Messages are not falsifiable.** Key Message 13.4 is but one of many examples: “Equitable Distribution of Transportation Trade-offs and Benefits Requires Community Involvement.”
- **Failure to acknowledge benefits** of warming and additional atmospheric CO₂ (CWG25 Section 2.1, Chapter 9)
- **Inadequacy of the peer review process.** The review of the NCA5 Third Order Draft by National Academies of Science, Engineering and Medicine (NASEM) identified some of the deficiencies we have noted, but the NCA5 authors were not obligated to adopt the NASEM recommendations. More importantly, we’ve identified many other deficiencies in NCA5; the NASEM review did not point them out and thus lacked the rigor expected of NASEM reports.

8.3 Suitability for informing Federal climate and energy policy

We assess that the selection and presentation of information in NCA5 makes it an unreliable basis for U.S. climate and energy policy making. For each of the elements of knowledge characterization suitable for risk management listed in Section 1.3, here are specific examples where NCA5 falls short:

- The degree to which the assumptions made are reasonable/realistic based on background knowledge
 - NCA5 focused on implausibly extreme scenarios for emissions and sea level rise and made policy recommendations without adequate consideration of the costs
- The degree to which data/information exists and are reliable and relevant
 - NCA5's unjustified assumptions about model reliability, and its use of short time periods for analysis, does not support its high-confidence conclusions
- The degree to which there is disagreement among experts, including those from different environments or academic fields
 - While NCA5 was an interdisciplinary effort, the concerns we have raised all point to a failure to canvass or communicate the full range of evidence, including data and research findings that speak against Key Messages.
- The degree to which the phenomena involved are understood and accurate models exist
 - NCA5 is not appropriately skeptical of the ability of climate models to attribute the causes of warming and extreme events or to project future climates, especially at the regional level
- The degree to which the knowledge has been thoroughly examined with respect to unknown knowns
 - A major NCA5 shortcoming is its dismissal of natural climate variability in many contexts where it should have been a major consideration

NCA5 is also problematic for informing policy because its exaggerated language promotes alarm and advocates for specific policies without a proper risk analysis. The NASEM Review of the NCA5 underscores the endemic nature of this problem - their review appears to be written by authors who share many of the biases of the NCA5 team, with an inordinate focus on social and policy issues. ~~It is then not surprising that objectivity can suffer when climate scientists communicate their understanding to non-experts. Further, the field of climate science has been politicized by NetZero mandates. This lack of objectivity usurps the public's right to make informed choices and undermines their confidence in the scientific enterprise.~~

~~Philip Handler, President of the National Academy of Sciences, identified the problem forty-five years ago in an editorial that still resonates:~~

~~Difficulty arises in the scientific community from confusion of the role of scientist *qua* scientist with that of scientist as citizen, confusion of the ethical code of the scientist with the obligation of the citizen, blurring the distinction between intrinsically scientific and intrinsically political questions. When scientists fail to recognize these boundaries, their own ideological beliefs, usually unspoken, easily becloud seemingly scientific debate.~~

~~[ALTHOUGH I VERY MUCH LIKE THIS TEXT, I THINK WE SHOULD DELETE IT IN AN EFFORT TO REMAIN CIRCUMSPECT]~~

NCA4 was a better policy-informing assessment than NCA5. It offered a more thorough consideration climate science, consistently used data back to 1901, and had less of an advocacy tone. But NCA4 is almost a decade out of date. More importantly, it shares NCA5's endemic problems of overconfident conclusions, inadequate treatment of natural variability, inadequate traceable accounts and communication of uncertainty, and over reliance on extreme scenarios.

8.4 Recommendations for NCA6

While we have assessed NCA5 to be scientifically inadequate and unsuitable as a basis for decision-making, one can imagine a different National Climate Assessment that meets statutory and policymaker requirements. The goal should be not to persuade, but to impart understanding by being objective, transparent and complete. A suitable NCA would be an important complement to IPCC assessments to the extent that its analysis and conclusions differ from the “consensus” of the IPCC reports and additional topics are addressed. Such a report would promote a more open scientific discussion and a more informed policy debate.

We recommend that the NCA6 have a narrower scope than NCA5, refocusing on climate science, including natural climate variability, with topics to include:

- How the climate has changed in the past. The U.S. has the best and longest meteorological records and they should be examined and displayed in their entirety. Trend analyses should include longest periods available and employ suitable statistical methods. Local paleoclimate data should be considered where available. Analysis should demonstrate not only how the climate has varied and changed, but also regional heterogeneity. Standard, easily understandable metrics should be employed.
- The range of climatic and weather conditions, including extremes, that have occurred in the past and can reasonably be expected to occur in U.S. regions over the near future. A salient example of an acute failure is NCA5 Chapter 26, which fails to mention the historical occurrence and future risk of flash floods in the Texas Hill Country **ROSS MAYBE MENTION WHAT NCA5 SAID ABOUT TX FLOODS in REGIONAL CHAPTER. THEN INCLUDE LINK TO YOUR MINI ANALYSIS**
- A critical survey of current global and regional modeling capabilities and their suitability for regional impact assessments and projections. This would include an assessment of their ability to reproduce observed changes. It should also discuss alternative methods for generating scenario projections on regional and decadal scales, along the lines of Chapter 10 of the IPCC AR6 WGI Report.
- Assessment of the impacts of recent historical climate variability and change on ecosystems and society. Where long-term data indicate a detectable regional change, regional projections can be made for the period 2030-2050. Emissions scenarios exceeding RCP4.5/SSP2-4.5 and ECS values exceeding 4°C should not be used. Regional projections to 2100 have no credibility at this time and so should not be included in NCA6.

It is important that climate projections be assessed in context of current science capabilities. The pressures toward spatially or temporally precise projections should be resisted as the current models are nowhere up to the task (an example is discussed in CWG25 Section 5.8). In that light, the many pages of NCA5 devoted to projected regional and sectoral impacts have little value.

Given the substantial deficiencies and bias in NCA5 that we have identified, producing an objective NCA6 report with the current NCA organizational construct would be a challenge. A NASEM review could help, but only if the selected participants reflect full viewpoint diversity and do not simply mirror the assumptions and biases of past NCA teams. We regard the CWG25 report to be a good start on NCA6 in terms of scope and objectivity, including adherence to the tenets of Gold Standard Science.

More broadly, we recommend a rewrite of the Global Change Research Act. The current mandate is vague and off point, allowing successive NCA teams to interpret the mandate as they see fit.

Moreover, it is becoming increasingly clear that current and foreseeable models are not fit-for-purpose to describe regional climates, let alone usefully project them for 25 to 100 years. Further, the use of the term “global change” is ambiguous and outdated.

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10 APPENDIX: CHARGE TO THE REVIEW

ABOUT THE AUTHORS

[Insert updated bios]

From: Steven Koonin <steven.koonin@gmail.com>
Sent: Saturday, June 21, 2025 6:36 AM
To: 'Travis Fisher'; 'Roy Spencer'
Cc: 'Judith Curry'; 'Ross McKittrick'; 'John Christy'; 'Josh Loucks'; 'Cohen, Seth'
Subject: RE: June 20 docs
Attachments: image001.jpg

I think this is OK. [There is a wayward "15 U.S.C. 2936." that needs to be placed properly or deleted.]

SEK

From: Travis Fisher <travis.scott.fisher@gmail.com>
Sent: Friday, June 20, 2025 4:48 PM
To: Roy Spencer <roywspencer@hotmail.com>
Cc: Steven Koonin <steven.koonin@gmail.com>; Judith Curry <curry.judith@gmail.com>; Ross McKittrick <ross.mckittrick@gmail.com>; John Christy <climateman60@gmail.com>; Josh Loucks <loucksj14@gmail.com>; Cohen, Seth <seth.cohen@hq.doe.gov>
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Please let me know if you have any suggested edits to the attached markup. Also, if you want to hear the backstory, please feel free to call me at 202-302-9953.

I don't think this edit to the tasking letter will require changes to the report, but I do think it's fair game to include positive suggestions in the report like "NCA6 authors could avoid these errors by ____." Up to you all.

On Fri, Jun 20, 2025 at 3:23 PM Roy Spencer <roywspencer@hotmail.com> wrote:

Anthropogenic... Or Natural?

Sent from my Verizon, Samsung Galaxy smartphone

----- Original message -----

From: Steven Koonin <steven.koonin@gmail.com>
Date: 6/20/25 2:18 PM (GMT-06:00)
To: 'Judith Curry' <curry.judith@gmail.com>, 'Ross McKittrick' <ross.mckittrick@gmail.com>
Cc: 'Travis Fisher' <travis.scott.fisher@gmail.com>, 'John Christy' <climateman60@gmail.com>, "'Roy W. Spencer'" <roywspencer@hotmail.com>, 'Josh Loucks' <loucksj14@gmail.com>, "'Cohen, Seth'" <seth.cohen@hq.doe.gov>

Subject: RE: June 20 docs

On the title, something like "Conflation of anthropogenic and natural changes" might be better.

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Sent: Friday, June 20, 2025 3:02 PM
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I'm working on summary/conclusions section

But i'm thinking we need to add a chapter to the main text:

Inadequate discrimination between natural and human-induced causes of trends and variability (long title but you get the idea)

Among other things, this would include the little para that was formerly a footnote that is now homeless, and also much of the NASEM text.

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Today's draft with post-meeting tidying.

Also, draft charge letter.

-Ross

Judith Curry, President
CFAN - Climate Forecast Applications Network
Reno, NV USA
curry.judith@cfanclimate.com | +1.404.803.2012
<http://www.cfanclimate.net>

From: Travis Fisher <travis.scott.fisher@gmail.com>
Sent: Friday, June 20, 2025 6:30 PM
To: Ross McKittrick
Cc: Judith Curry; Roy Spencer; Steven Koonin; John Christy; Josh Loucks; Cohen, Seth
Subject: Re: June 20 docs

I think there's room to criticize the mandate or show how it's not feasible, even as you give advice on how best to satisfy it as currently written.

Just know that the probability of changing the statute any time soon is very low, even though it's a great idea. Then again, I'm a Cato guy, and I ask for low-probability reforms all the time. #repealtheJonesAct

On Fri, Jun 20, 2025 at 6:17 PM Ross McKittrick <ross.mckittrick@gmail.com> wrote:

I like the idea of suggesting a revised mandate. I think the fact that the current one is so vague and off-point is one reason each team just does whatever they want.

On Fri, Jun 20, 2025 at 5:51 PM Judith Curry <curry.judith@gmail.com> wrote:

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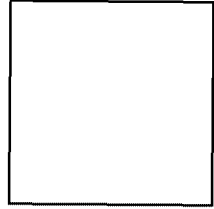
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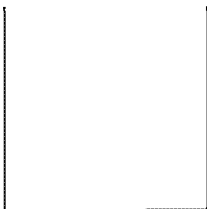
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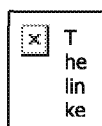
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From: Judith Curry <curry.judith@gmail.com>
Sent: Friday, June 20, 2025 5:51 PM
To: Travis Fisher
Cc: Roy Spencer; Steven Koonin; Ross McKittrick; John Christy; Josh Loucks; Cohen, Seth
Subject: Re: June 20 docs

Travis, we considered recommendations for NCA6 to be part of a follow on report. But since we do have several weeks yet, perhaps we could tackle this to some extent (but many are on travel in coming weeks).

One issue is that there is a fundamental flaw with the NCA mandate, and that is with regards to making projections 25 and 100 years into the future - climate models are not fit for this purpose. Another issue is that the term "global change" is ambiguous and is no longer in use for that reason. Personally I would recommend that the entire mandate be reconsidered. Failing that, we could make some specific recommendations in context of the existing mandate

On Fri, Jun 20, 2025 at 1:48 PM Travis Fisher <travis.scott.fisher@gmail.com> wrote:

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On Fri, Jun 20, 2025 at 3:23 PM Roy Spencer <roywspencer@hotmail.com> wrote:

Anthropogenic... Or Natural?

Sent from my Verizon, Samsung Galaxy smartphone

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From: Steven Koonin <steven.koonin@gmail.com>

Date: 6/20/25 2:18 PM (GMT-06:00)

To: 'Judith Curry' <curry.judith@gmail.com>, 'Ross McKittrick' <ross.mckittrick@gmail.com>

Cc: 'Travis Fisher' <travis.scott.fisher@gmail.com>, 'John Christy' <climateman60@gmail.com>, 'Roy W. Spencer' <roywspencer@hotmail.com>, 'Josh Loucks' <loucksj14@gmail.com>, 'Cohen, Seth' <seth.cohen@hq.doe.gov>

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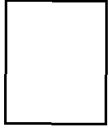
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CC: Steven Koonin [steven.koonin@gmail.com]; Judith Curry [curry.judith@gmail.com]; Ross McKittrick [ross.mckittrick@gmail.com]; John Christy [climateman60@gmail.com]; Josh Loucks [loucksj14@gmail.com]; Cohen, Seth [seth.cohen@hq.doe.gov]
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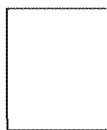
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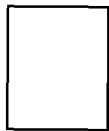
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Review of the Fifth National Climate Assessment

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EXECUTIVE SUMMARY

This report critically evaluates the Fifth National Climate Assessment (NCA5), finding it an inadequate basis for climate and energy policies. A detailed review of the foundational chapters on climate science raises several key concerns:

Scientific Integrity

- An advocacy tone, particularly in the Overview chapter, inconsistent with scientific objectivity
- An endemic overconfidence when stating conclusions, including inflated certainty levels and overstatement of findings from underlying sources

Flawed methodology

- Use of *ad hoc* time scales for trend analyses in areas such as precipitation and heatwaves
- An overemphasis on extreme scenarios for future emissions
- Inadequate traceable accounts to support key conclusions

Deficient Review Process

- A review by the National Academy of Sciences, Engineering, and Medicine (NASEM) failed to challenge some fundamental flaws in NCA5
- The NCA5 authors failed to adopt some improvements recommended by NASEM

The report shows NCA5 to be a biased and incomplete picture of climate science that skews toward excessive climate risk. Consequently, NCA5 should not be used as basis for climate and energy policies.

1 INTRODUCTION

1.1 About this Report

This report responds to a request from OSTP Director Michael Kratsios (reproduced in Appendix 1) that we assess the suitability of the Fifth National Climate Assessment (NCA5 2023) for informing climate and energy policies.

To conduct this assessment we reviewed NCA5 itself, the National Academies of Science, Engineering and Medicine (NASEM) review of the Third Order Draft, and the USGCRP responses to that review. We have drawn upon our long experience working on advisory reports, including for the NASEM, the Intergovernmental Panel on Climate Change (IPCC) and other organizations, as writers, reviewers and study leaders.

We find that NCA5 should not be relied on for policy making as it is an incomplete and misleading picture of our understanding of the changing climate and the risks it poses to the nation. NCA5 was selective and incomplete in its survey of climate science as of its publication in 2023 and has become even more so in the years since. We have reviewed many key scientific developments in a separate report to Energy Secretary Wright (Climate Working Group 2025, herein denoted “CWG25”). The overall effect of the biases and omissions of NCA5 is an excessively dire picture of climate risk.

To support our finding, the following sections of this chapter provide some background on the National Climate Assessments and the standards by which we have assessed NCA5. Chapters 2 through 6 detail important ways in which NCA5 fails to meet those standards. Chapter 7 then follows with an assessment of the NASEM review. Finally, Chapter 8 summarizes our evaluation of NCA5.

1.2 About the National Climate Assessments

The U.S. Global Change Research Program (USGCRP) was established by Presidential Initiative in 1989 and mandated by Congress in the Global Change Research Act (GCRA) of 1990 to develop and coordinate “a comprehensive and integrated United States research program which will assist the Nation and the world to understand, assess, predict, and respond to human-induced and natural processes of global change.”

The National Climate Assessment (NCA) Reports evolved from the GCRA requirement to

Prepare and submit to the President and the Congress an assessment which (1) integrates, evaluates, and interprets the findings of the Program and discusses the scientific uncertainties associated with such findings; (2) analyzes the effects of global change on the natural environment, agriculture, energy production and use, land and water resources, transportation, human health and welfare, human social systems, and biological diversity; and (3) analyzes current trends in global change, both human-induced and natural, and projects major trends for the subsequent 25 to 100 years.

The five NCA Reports to date have interpreted this mandate in different ways:

- NCA1 (2000) was a multidisciplinary effort to study and portray in regional detail the potential effects of human-induced global warming on the United States.
- NCA2 (2009) was a relatively short report that not only focused on the potential consequences of climate change but also sought to identify potential adaptation measures and identify the highest priorities for future research.

- NCA3 (2014) was an expanded effort that continued along the lines of NCA2, and was distinguished by a comprehensive review process, including a review by the National Academy of Sciences. NCA3 introduced a traceability analysis for each key finding, including a description of uncertainties.
- NCA4 (2017/2018) was a further expanded effort published in two volumes: I Climate Science Special Report, and II Impacts, Risk, and Adaptation in the United States. This was the first NCA report to devote significant effort to assessing climate science.
- NCA5 (2023) returned to a single volume format, reducing discussion of climate science to a cursory two chapters, with continuing with a focus on regional and sectoral impacts of climate change. NCA5 expanded its remit to topics that are arguably outside the purview of the USGCRP, focusing on “Climate Action” and policy recommendations with a social justice emphasis. NCA5’s self-description is reproduced as Appendix II.

These successive interpretations of the NCA are poorly aligned with the GCRA’s statutory requirements. Only NCA4 gives serious consideration to climate science, which receives the great majority of USGCRP funding, and even then misrepresents some important points (Section 1.4 below offers an example). Natural climate variability is essentially dismissed as unimportant in NCA4 and barely mentioned in NCA5 in most contexts, despite the mandate to include both human-caused and natural climate change. Most significantly, NCA5 has redirected the focus away from climate science and even the hazard elements of impacts, towards evaluation of societal vulnerabilities and advocacy for particular policy options, especially wind and solar power. The cover image for the NCA5 Report is the installation of a solar panel.

1.3 Standards for Assessing NCA Products

Beyond the statutory requirements stated above, we draw attention to two other pertinent standards. President Trump’s executive order of May 23, 2025, “Restoring Gold Standard Science” enumerates some of the characteristics of good science:

- i. reproducible;
- ii. transparent;
- iii. communicative of error and uncertainty;
- iv. collaborative and interdisciplinary;
- v. skeptical of its findings and assumptions;
- vi. structured for falsifiability of hypotheses;
- vii. subject to unbiased peer review;
- viii. accepting of negative results as positive outcomes; and
- ix. without conflicts of interest.

Although these should be self-evident to those trained in science, it is surprising that some scientists have found them controversial (Dellawalla et al. 2025).

There are other desiderata for scientific reports that will be highly influential on climate policymaking. Among them are statements about the strength of climate knowledge. The IPCC’s approach is based on judgment of the available evidence and agreement among experts. More sophisticated knowledge characterizations for risk management include (Arven 2017):

- The degree to which the assumptions made are reasonable/realistic based on background knowledge
- The degree to which data/information exists and are reliable and relevant
- The degree to which there is disagreement among experts (including those from different environments or academic fields)
- The degree to which the phenomena involved are understood and accurate models exist
- The degree to which the knowledge has been thoroughly examined with respect to unknown knowns

Good climate and energy policies balance the risks and benefits of a changing climate against the world's growing demand for reliable and affordable energy. To strike that balance, policymakers must understand at least two complex and nuanced topics: the certainties and uncertainties of climate science and the technoeconomic realities of energy systems. Experts in those subjects have a responsibility to communicate their understanding to non-experts clearly, completely, and without bias.

Expertise in energy systems resides largely in the private sector, where it is essential to providing the reliable and affordable energy services that are the lifeblood of society. Understanding is therefore continually refined and tested by the discipline of the marketplace. In contrast, climate science expertise is found largely in the non-profit realm of universities and government laboratories and so has a more academic character.

In recent decades, climate science has engendered passion and emotion. Indeed, some younger climate scientists have gone into the field to “save the planet.” Further, the field of climate science has been politicized by NetZero mandates. It is then not surprising that objectivity can suffer when climate scientists communicate their understanding to non-experts. This lack of objectivity usurps the public's right to make informed choices and undermines their confidence in the scientific enterprise.

In 1980, then-President of the National Academy of Sciences Philip Handler identified the problem in an editorial (Handler 1980) that resonates eerily four decades later:

Difficulty arises in the scientific community from confusion of the role of scientist *qua* scientist with that of scientist as citizen, confusion of the ethical code of the scientist with the obligation of the citizen, blurring the distinction between intrinsically scientific and intrinsically political questions. When scientists fail to recognize these boundaries, their own ideological beliefs, usually unspoken, easily becloud seemingly scientific debate.

1.4 When Peer Review Fails

Peer review of reports like IPCC and NCA products is not a silver bullet that guarantees quality. The peer review process for these reports differs in some important respects from traditional peer review in academic journals. First, during the open review phases of early NCA drafts reviewers are volunteers who self-select what parts of the report to read, whereas the editors of academic journals editors recruit reviewers with relevant expertise and assign them to specific papers. As a result, there is no guarantee at that stage that any particular section of an NCA report was reviewed by anyone, let alone by someone with a perspective that differs from the authors. In fact, many potential reviewers have given up over the years because their input has systematically been ignored. The

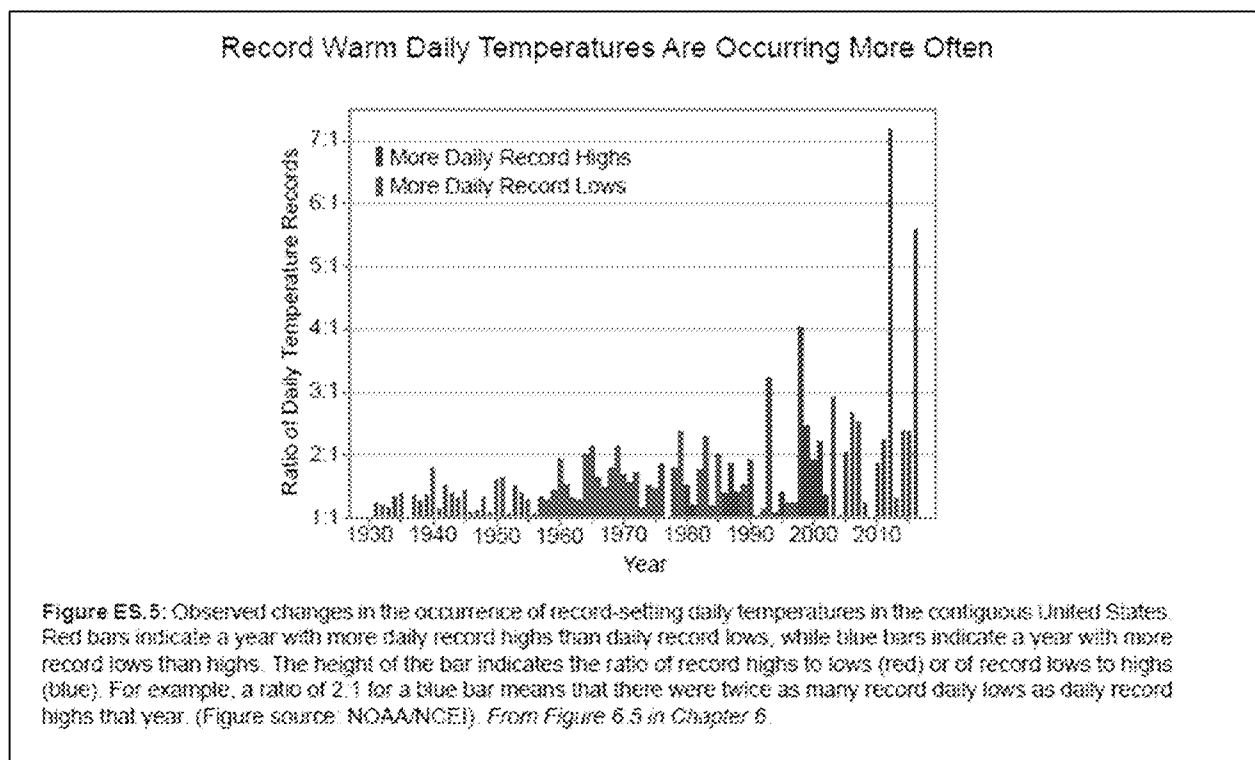
introduction of a NASEM review stage is at best a partial remedy for this. However, NCA authors have near complete authority whether to accept or reject review comments. By contrast, the Editor of an academic journal mandates the author to respond, and the reviewer and Editor assess its adequacy. Finally, the work of an NCA chapter author team is guaranteed to be published, whereas academic journals routinely reject papers that do not pass review.

These points are important to bear in mind because some readers might dismiss any criticism of NCA products out of hand on the grounds that they were “peer reviewed”. But the test of a report is whether its contents are a valid representation of the available evidence. Here we give an example in which NCA4 gave prominence to a figure that completely misrepresented the underlying data and which evaded peer review to do so. Further details can be found in Koonin (2024).

As shown in CWG25 Section 6.3 the number of heat extremes in the U.S. peaked in the 1930s and has declined ever since. Considering cold and hot extremes together the U.S. the U.S. climate has become more moderate over time. NCA4’s Part I says (prominently and with *Very High Confidence*) on Page 19 of the Executive Summary:

There have been marked changes in temperature extremes across the contiguous United States. The number of high temperature records set in the past two decades far exceeds the number of low temperature records.

and offers this figure in support:

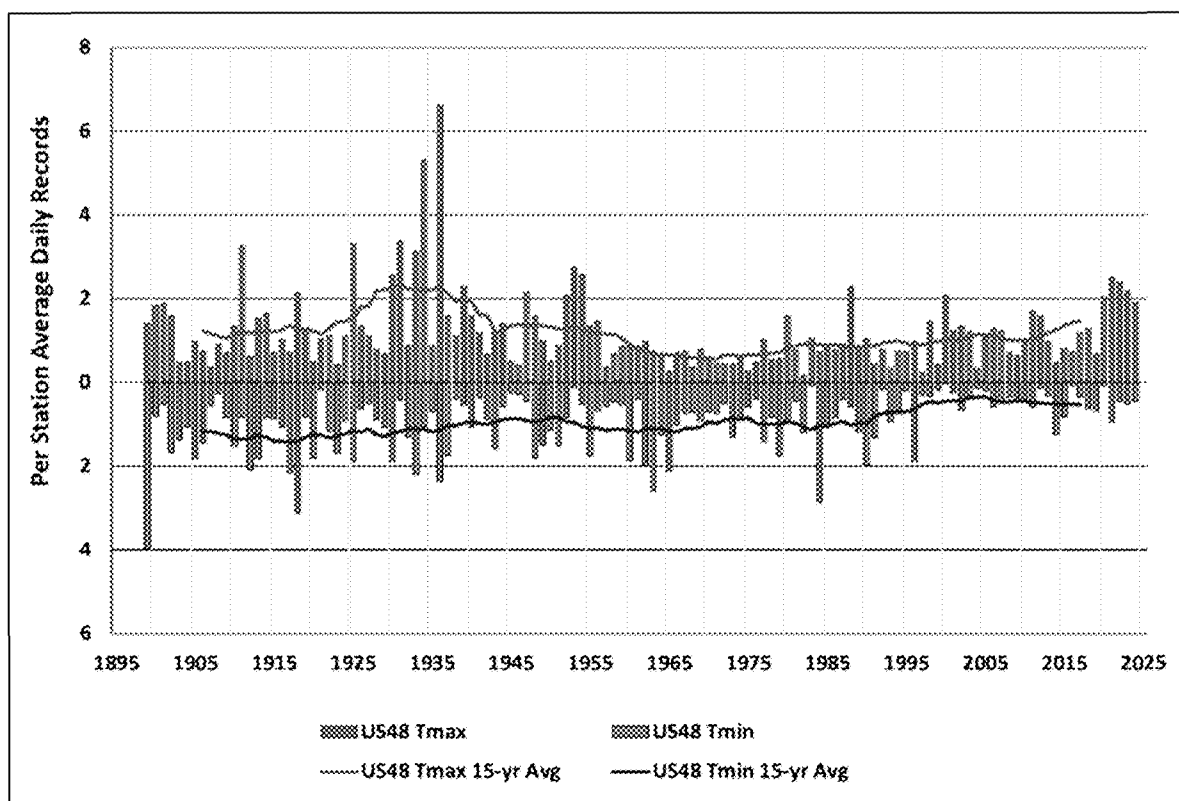


The figure appears to validate the claim that record warm daily temperatures are occurring more often. But the underlying data do not. Rather, they show that extreme heat in the U.S. peaked in the

1920s and 1930s and declined thereafter, as supported by Figure 6.4 deep within the CSSR itself (reproduced in our Section 4.2 below).

Figure ES.5 does not even show what its title implies, as it displays not simple counts of cold and warm extreme events, but rather ratios of the two counts. In fact, both types of extremes declined over the sample interval, but cold events declined more than warm events, so the ratio of warm extremes to cold extremes increased. By graphing the ratio instead of counts, NCA4 creates a visual impression opposite to what is in the data.

Figure 6.3.3 of CWG25 (reproduced below) shows the results of a proper analysis of the data – defining each record as the singular extreme in the sample interval, displaying numbers of warm and cold records separately, and beginning the analysis in 1899 rather than 1930. It makes evident the exceptional heat of the 1920s and especially the 1930s, peaking in 1936. The increased heat of the past five years is too brief to be deemed climatically significant and, in any event, occurred after the CSSR was published in 2017. The frequency of cold records has declined, especially over the last quarter of the period in which only 13 percent of the extreme cold events were measured. In contrast, 25 percent of the heat records were achieved in the last quarter, which is consistent with statistical expectations. As a result, the ratio of heat to cold extremes shown in Figure ES.5 of the CSSR explodes in recent decades. The overall reduction in numbers of both cold and hot extremes over the past century indicates a climate *less* prone to extremes, in sharp contrast to the message of NCA4 Figure ES.5.



Number of daily record High (red) and Low (blue) temperatures for warm and cold seasons in the CONUS. The lines represent the 15-year running, centered average. Source: 1,211 USHCN stations supplemented as needed to achieve a minimum of 92 percent of observations in the 126-

year period since Dec 1898. US48: contiguous U.S. states. Tmax: maximum temperature. Tmin: minimum temperature. Source: CWG25 Figure 6.3.3.

The National Academies' expert review panel criticized the discussion of temperature extremes in a late draft of the CSSR. In reference to the CSSR's Key Finding 2 of Chapter 6, they said:

Further, it is difficult to understand how a statement that includes increases in extreme warmth can be associated with a high confidence or extremely likely statement, given that most of the graphics in this chapter show a decrease in extreme warmth in the historical record.

The Federal official in charge of the CSSR (Michael Kuperberg, Executive Director of the USGCRP) responded to the Academies' review by noting that

Almost every recommendation from the NAS was incorporated [in the final version]... and a new figure was added on changes in record high and low temperatures

The "new figure" referred to is the Figure ES.5, which did not appear in the draft reviewed by the Academies' panel. It seems unlikely that the Academies panel ever saw that figure because they surely would have commented if they had and it wouldn't have survived to publication. And the figure's problems were evidently not flagged (or were ignored) in the subsequent internal government reviews.

With this background we now present our critique of NCA5.

2 NCA5 OVERVIEW CHAPTER: HYPERBOLIC ADVOCACY LANGUAGE AND UNSCIENTIFIC TONE

NCA5 Chapter 1, "Overview", holds a prominent place in the Report since it summarizes the entire report and is the only section that many will read. Although the later chapters of NCA5 contain much sound scholarly content, Chapter 1 is marred by an activist tone and language that aggressively promotes mitigation policies. As such, this chapter adds an imprimatur of scientific authority to oversimplified declarations of opinion about public policy. Many examples can be cited; here we note a few that are particularly egregious.

Chapter 1 opens as follows:

The more the planet warms, the greater the impacts. Without rapid and deep reductions in global greenhouse gas emissions from human activities, the risks of accelerating sea level rise, intensifying extreme weather, and other harmful climate impacts will continue to grow. Each additional increment of warming is expected to lead to more damage and greater economic

losses compared to previous increments of warming, while the risk of catastrophic or unforeseen consequences also increases.

This statement presupposes that all warming is anthropogenic, that all warming is bad and causes economic damage, and that warming intensifies extreme weather. Such sweeping generalizations go well beyond what science has or can establish. The statement also refers to growing risks without saying whether they were large to begin with -- a small risk that grows may still be a small risk, and a large risk may be only incrementally worsened. A scientifically-sound version of this paragraph would instead say something like the following:

The Earth is warming because of a combination of natural and anthropogenic influences. This warming will generate a mix of benefits and harms that varies by region, to which society should be prepared to adapt. Some types of extreme weather have worsened recently, while others have not changed or have even declined in intensity. Reducing emissions of greenhouse gases might slow the warming although such policies have proven to be costly and disruptive, so any climate actions to be weighed against the potential benefits.

On the next page the Overview states:

Each additional increment of warming leads to greater risks [here it lists 7 key components of society including food security and the economy]... Without deeper cuts in global net emissions, climate risks to the US will continue to grow... Action to limit future warming and reduce risks can have near-term benefits and opportunities: low-carbon energy jobs, Improved air quality, Health benefits, Economic benefits..."

The authors write as if climate policy does not involve trade-offs and all measures to reduce future warming will be effective and beneficial. But the vast body of scholarship on climate science and economics does not support such simplistic claims. Not every additional increment of warming leads to economic harms; in fact, NCA5 Chapter 19 acknowledges that there will also be benefits. Nor is climate policy guaranteed to create jobs or benefit the economy; in many cases it has done the opposite. Such deceit is a disservice to policymakers.

Pages 8 and 9 of the Overview promote renewable energy options by noting, correctly, that the leveled costs of wind/solar generation have fallen sharply since 2010, and so offers this rationale for pursuing deep emission reductions:

Recent growth in the capacities of wind, solar, and battery storage technologies is supported by rapidly falling costs of zero- and low-carbon energy technologies, which can support even deeper emissions reductions. For example, wind and solar energy costs dropped 70% and 90%, respectively, over the last decade, while 80% of new generation capacity in 2020 came from renewable sources.

Yet it has long been known that intermittent renewables generation must be supplemented by dispatchable generation to meet grid reliability standards, and that doing so (e.g., through natural gas, fission, or storage) significantly increases the cost of electricity. Further, there are yet unmet synchronization challenges in transmission grids with heavy penetration of wind and solar power. Here again it is advisory malpractice not to acknowledge these facts.

Page 14 of the Overview presents future emission scenarios with the following description: "Climate modeling experts develop global climate projections for a range of plausible futures." The word

“plausible” is applied to all of the scenarios. The accompanying Figure includes both SSP3-7.0 and SSP5-8.5, the latter reaching the same radiative forcing as RCP8.5. The Figure does not compare observed emissions with previous projections nor does it caution readers that SSP3-7.0 and SSP5-8.5 are extreme worst case scenarios that, like RCP8.5, have been heavily criticized in the scientific literature (CWG25 3.2.1). By describing the entire envelope of emission projections as “plausible” the report opens the door to later presenting impacts associated with extreme and implausible emission scenarios as part of a baseline “business-as-usual” future.

Page 17 of the Overview introduces the discussion of risks from extreme weather events by saying “Harmful impacts from more frequent and severe extremes are increasing across the country.” This creates the impression that disaster losses are driven by trends in extreme weather. While the section goes on to acknowledge that some of the increase is due to increases in the value of assets at risk it then invokes the NOAA Billion Dollar Dataset as evidence of extreme weather getting worse. Scientists have shown that this is an invalid metric (CWG 10.2) since it measures the growth of the economy not the frequency of extreme weather, and indeed NOAA has recently withdrawn the data product (Pielke Jr. 2024, 2025). Even though it was still distributed by NOAA at the time of the NCA5, the report authors should have assessed it skeptically and seen that it was unfit for the purpose of measuring climate trends.

Page 23 of the Overview states, in large font:

Climate changes are making it harder to maintain safe homes and healthy families; reliable public services; a sustainable economy; thriving ecosystems, cultures, and traditions; and strong communities.

It is pointless to try to evaluate this statement on scholarly grounds; it is self-evidently hyperbolic. This kind of language doesn’t belong in a scientific assessment report. Its prominent inclusion points not only to the willingness of NCA5 authors to promote alarm, but also the ineffectiveness of the review process in not ensuring such statements are removed.

3 OVERCONFIDENCE WHEN STATING CONCLUSIONS

3.1 Inflated certainty levels

Overconfidence in stating conclusions is an endemic problem in NCA5. The authors frequently make sweeping generalizations without appropriate caveats or acknowledging uncertainties. The overconfidence begins with inflated language to describe certainty levels.

NCA5 uses specific terms to convey information about scientific confidence associated with important finds, observations and projections. The Front Matter of NCA5 states that

confidence in a finding is based on the type, amount, quality, strength, and consistency of evidence; the skill, range, and consistency of methods to detect, evaluate, attribute, and interpret climate trends; and the degree of agreement across scientific information sources.

and Table 1 from the Front Matter provides calibrated language for confidence assessment:

Very high: Strong evidence (established theory, multiple sources, well documented and accepted methods, etc.). High consensus

High:	Moderate evidence (several sources, some consistency, methods vary and/or documentation limited, etc.). Medium consensus
Medium:	Suggestive evidence (a few sources, limited consistency, methods emerging, etc.) Competing schools of thought.
Low:	Inconclusive evidence (limited sources, extrapolations, inconsistent findings, poor documentation and/or methods not tested, etc.). Disagreement or lack of opinions among experts.

This terminology is inflated: *high confidence* with just moderate evidence and medium consensus; *medium confidence* with only suggestive evidence and competing schools of thought. This inflation in terminology leads to overconfidence in conclusions.

Even with this inflated terminology, NCA5 further inflates the confidence level of many of its conclusions to well beyond what the IPCC has concluded with more thorough justification, and also by incorrectly applying its own standards. An example is the conclusion about anthropogenic influence on climate change, arguably one of the most important scientific statements of the report.

Key Message 3.1 Traceable Account states:

There is *very high confidence* that emissions of GHGs from human activities, fossil fuel use in particular, have unequivocally caused *all* global warming observed over the industrial era.

while the corresponding statements from IPCC AR5 and AR6 are

AR5: It is *extremely likely* that *more than half* of the observed increase in global average surface temperature from 1951 to 2010 was caused by the anthropogenic increase in greenhouse gas concentrations and other anthropogenic forcings together.” (IPCC, 2013)

AR6: The *likely* range of total human-caused global surface temperature increase from 1850–1900 to 2010–2019 is 0.8°C to 1.3°C, with a best estimate of 1.07°C. It is *likely* that well-mixed GHGs contributed a warming of 1.0°C to 2.0°C, other human drivers (principally aerosols) contributed a cooling of 0.0°C to 0.8°C, natural drivers changed global surface temperature by –0.1°C to +0.1°C, and internal variability changed it by –0.2°C to +0.2°C. It is *very likely* that well-mixed GHGs were the main driver of tropospheric warming since 1979.

The IPCC AR5 and AR6 statements provide likelihood assessments but not a confidence level. While NCA5 claims with *very high confidence* that fossil fuels have unequivocally caused *all* global warming, AR5 refers to “*more than half* of the observed warming” and AR6 provides a more nuanced statement that relates to a *likely* range of warming contributed to by human drivers.

3.2 Overstating findings in underlying sources

Although we did not do a detailed audit of NCA5’s use of source material, spot checks turned up evidence of a pattern of overstatement.

Chapter 2 page 11 reports on an increase in precipitation in some areas and attributes it to “climate change”:

Many eastern regions of the country are getting wetter (Figure 2.4). Average annual precipitation from 2002-2021 was 5%-15% higher relative to the 1901-1960 average in the central and eastern US, a trend attributable to climate change.

Note that the attribution of various changes to “climate change” is misleadingly ambiguous. Because NCA5’s Glossary defines “climate change” as a change in climate for any reason, the statement is a tautology and so the attribution is superfluous. But because the popular perception of climate change is anthropogenic, its gratuitous inclusion effectively attributes the changes to greenhouse gas emissions. The NASEM review (pp. 23-24) commented on this problem but their comment was ignored.

The change metric in NCA5 Figure 2.4 is non-standard; we will discuss NCA5’s inconsistent choices of time scales of analysis below. The claims were attributed to Knutson and Zeng (2018). But Knutson and Zeng did not say these things. They examined linear trends over 1901 – 2010, 1951 – 2010 and 1981 – 2010. They did not compare average rainfall over 2002 - 2021 to average rainfall over 1901 – 1960, if only because their study was published in 2018. For 1981-2010, they noted stronger trends in some areas but cautioned that such changes are consistent with natural variability, and they did not claim attributable trends were observed over the United States:

Observed annual precipitation trends over the recent 30-yr period 1981–2010 (Fig. 5) have generally stronger magnitudes (in mm yr⁻¹ decade⁻¹) than observed trends for 1901–2010 or 1951–2010. This is as expected since trends over a shorter period have stronger potential for occurrence of pronounced temporary trends due to internal variability alone. Only 9% of the analyzed area has detectable and attributable anthropogenic influence (categories –3, –2, +2, +3), which represents less than one-third of the fractional areal coverage of such trends for 1901–2010 (29%). ... Eight percent of the analyzed area has attributable anthropogenic *increases* (categories +2, +3), including parts of eastern Europe, northern Asia, northern Australia/Maritime Continent, and tropical Africa.

As another example of overstating findings, NCA5’s Chapter 2 page 18 states

There is robust evidence that human-caused warming has contributed to increases in the frequency and severity of the heaviest precipitation events across nearly 70% of the US.

This is allegedly attributed to two papers Diffenbaugh *et al.* (2018) and Kirchmeier-young and Zhang (2020). Diffenbaugh *et al.* presented ratios of observed occurrences of extreme events to simulated occurrence rates in CMIP6 models run with only natural forcings. They report that for 79% of the U.S. extreme rainfall event frequencies are currently higher than in model simulations, and the ratio of occurrences will rise under future warming simulations. This is not “robust” evidence of anthropogenic influence since it requires readers to assume that climate models provide accurate simulations of regional precipitation patterns, something that even IPCC AR6 admits is uncertain (AR6 WGI SPM Box SPM 1.2, SPM Section C.1.3).

Kirchmeier-Young and Zhang looked at extreme 1- and 5-day events in North America and, using three GCMs, found

A signal of combined anthropogenic and natural external forcing can be detected in the intensification of extreme precipitation at the continental scale over North America. In some cases, this intensification can be attributed to human influence specifically.

However, they noted large differences among the three models in their simulated precipitation changes. Also, two of the three models failed to yield attribution for 5-day events for the North America mean. In other words the models disagreed on whether the observed changes were anthropogenic. Both cited references utilized the implausible RCP8.5 scenario and began their “historical” observational records only in 1961. Here again this is not “robust” evidence, it is merely suggestive, particularly since other studies have found natural variability predominant.

3.3 Technical example: Emergent constraints

Some of the overconfidence expressed by NCA5 arises by omitting discussion of counterevidence in the peer reviewed literature. An example is the topic of “emergent constraints”. Chapter 3 page 17 invokes this concept to support its claim that key uncertainties have been reduced:

An approach to reduce uncertainty in climate change projections has matured over the past decade. It is known as “emergent constraints.” The term refers to strong statistical relationships between highly uncertain future climate parameters and observable trends or variations in the current climate, along with a physical explanation of this relationship.

Emergent constraints appeared in the climate modeling literature as an attempt to tie GCM behavior to climate observations in hopes of generating insight into real-world equilibrium climate sensitivity to a doubling of carbon dioxide (ECS). Climate models exhibit a wide range of ECS values. The idea of emergent constraints is to examine whether the models with shared sensitivity values also share a common representation of some climate process (usually related to clouds) that might indirectly influence ECS. Suppose, for instance, that in low-ECS models the total cloud fraction in the tropics is strongly correlated with that in the southern midlatitudes but in high-ECS models the correlation is weak. Then researchers could examine whether the observed correlation is strong or weak and draw a conclusion about which type of model, and therefore which ECS value, is more likely.

A problem in the emergent constraint literature is that there has been a proliferation of proposed correlations with little physical motivation. As shown by Schlund *et al.* (2020) many emergent constraints patterned on CMIP5 models (Coupled Model Intercomparison Project No. 5, used for the IPCC 5th Assessment Report) failed to work on CMIP6 models (used for the IPCC 6th Assessment Report). In other words, the observed correlations in CMIP5 models between ECS and cloud processes failed to show up in CMIP6 models, indicating that they were likely spurious rather than clues to physical processes governing the climate system. As a result, emergent constraints estimated on CMIP5 models increased the uncertainty of ECS, rather than narrowing it as intended and as claimed by NCA5.

Schlund *et al.* summarized the problem as follows [**boldface** used for emphasis]

In this study, we systematically analyze 11 published emergent constraints on ECS that have mostly been derived from models participating in the Coupled Model Intercomparison Project Phase 5 (CMIP5) project... The focus of the study is on testing if these emergent constraints hold for [Earth System Models] participating in the new Phase 6 (CMIP6). Since none of the emergent constraints considered here have been derived using the CMIP6 ensemble, CMIP6 can be used for cross-checking of the emergent constraints on a new model ensemble. **The application of the emergent constraints to CMIP6 data shows a decrease in skill and statistical significance of the emergent relationship for nearly all constraints, with this decrease being large in many cases.** Consequently, the size of the

constrained ECS ranges (66% confidence intervals) widens by 51% on average in CMIP6 compared to CMIP5.

Yet NCA5 described the use of emergent constraint analysis as a great “advance” that reduced uncertainty.

4 RELIANCE ON SHORT TIME PERIODS FOR TREND ANALYSIS

In CWG25 Chapter 6 we discussed the need for care in the choice of time scale when making claims about trends in extreme weather. We provided examples from analysis of river flooding, heatwaves, and extreme precipitation to show how assertions about apparent trends based on short data sets fall apart when looking at longer versions of the same data sets. Here are some examples of this problem from NCA5.

4.1 Average and Extreme Precipitation

McKittrick and Christy (2019) showed that apparently significant positive trends in U.S. average and extreme precipitation over the NCA4 interval (1901 – 2016) disappeared on longer samples (extending back as far as the 1840s, depending on location) or on a shorter interval coinciding with the final 40 years of the data then available (1978 – 2017). In CWG25 Section 6.4 we presented analyses of updated data for the same locations (and many others), in all cases finding both considerable regional heterogeneity and that trends detectable on one time scale are often not detected on longer or shorter time scales. These findings argue against simple attribution of changes to anthropogenic influences.

NCA5 did not continue the NCA4 precedent of using the post-1901 interval as the time scale for its precipitation discussion; instead it refers to changes “since the 1950s”; NCA5 Figure 2.8 suggests 1958 might be the intended start date. Under Key Message 2.2 “Extreme Events Are Becoming More Frequent and Severe” (p. 2-16) NCA5 states (p. 2-18):

Rainfall is becoming more extreme
Since the 1950s, there has been an upward trend in heavy precipitation across the contiguous US. This increase is driven largely by more frequent precipitation extremes, with relatively smaller changes in their intensity.

In addition to our concerns that inferences about trends are contingent on choice of time scale, we cannot reproduce the finding that positive trends are observed in extreme precipitation across all CONUS regions. We extended the data used in CWG25 (McKittrick and Christy 2025) to include 141 stations across the US in the Pacific Coast, Midwest, Northeast and Southeast regions (Christy 2025). See details in Appendix 3. Many post-1950 trends are positive but statistically insignificant depending on the measure of extreme precipitation. It is possible to find locations that support the NCA5 position, such as the Southeast post-1950, but results are not robust to selecting longer or shorter time scales of analysis nor do they generalize across all regions.

The following is a more accurate summary of what U.S. data show.

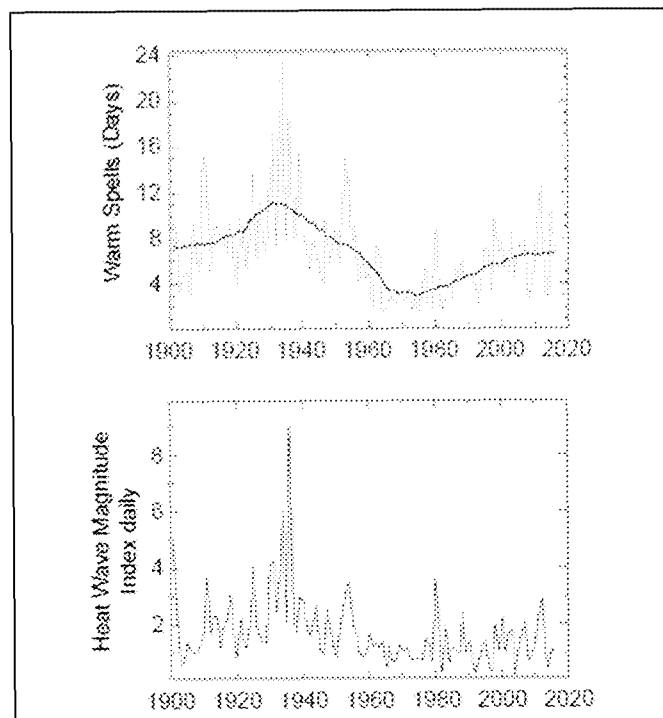
There are regionally heterogeneous changes in average and extreme precipitation. Positive trends in annual average rainfall and extreme events (defined either as the annual maximum or the number of exceedances of the 99th percentile value) are generally weak or non-existent when looking at samples exceeding 130 years in length. Significant trends can be found when beginning the sample in the 1950s although in most cases the trends weaken and become insignificant when looking at the post-1980 interval. This makes attribution of changes in precipitation to anthropogenic warming difficult.

4.2 Heatwaves

In contrast to NCA5, NCA4 examined heat extremes across the entire 20th century, pointing out that peak heat wave activity was reached in the 1930s and has decreased since then, and that recent increases are confined to areas west of the Rockies:

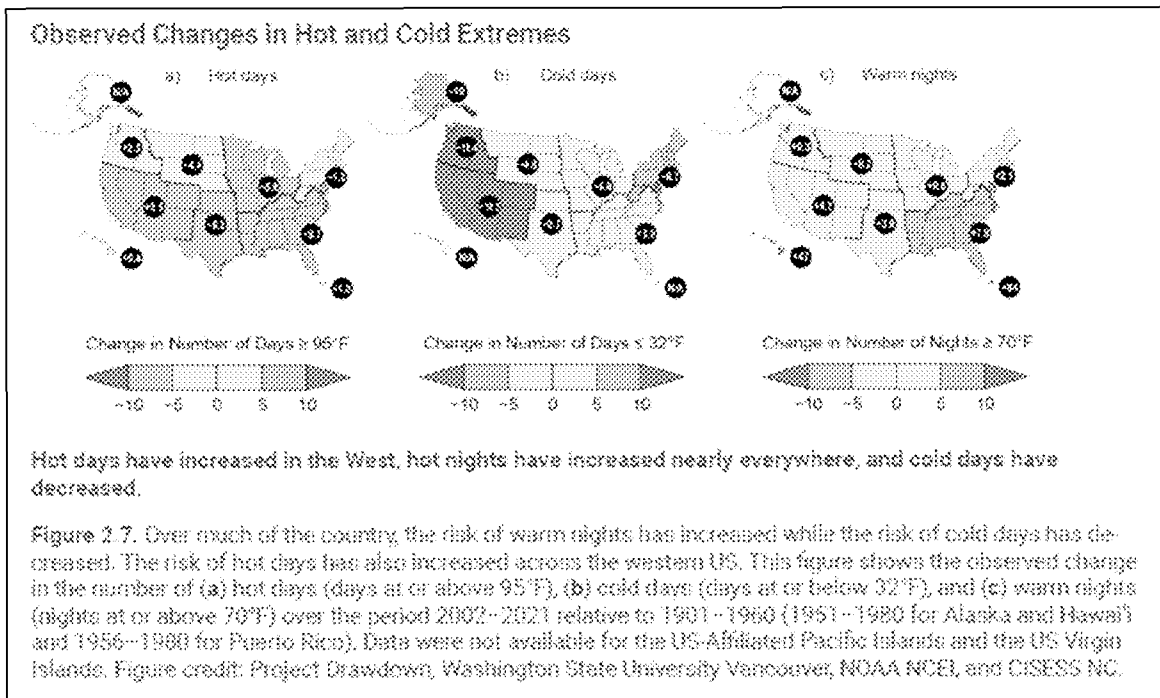
[The] warmest daily temperature of the year increased in some parts of the West over the past century, but there were decreases in almost all locations east of the Rocky Mountains. In fact, all eastern regions experienced a net decrease, most notably the Midwest (about 2.2°F [1.2°C]) and the Southeast (roughly 1.5°F [0.8°C]).

Since the mid-1960s, there has been only a very slight increase in the warmest daily temperature of the year (amidst large interannual variability). Heat waves (6-day periods with a maximum temperature above the 90th percentile for 1961–1990) increased in frequency until the mid-1930s, became considerably less common through the mid-1960s, and increased in frequency again thereafter. As with warm daily temperatures, heat wave magnitude reached a maximum in the 1930s. (NCA4 pp. 190-191)



U.S. Heat waves since 1900. Source: NCA4 Figure 6.4

Contrast this careful and factual language with NCA5 Key Message 2.2: “Extreme Events Are Becoming More Frequent and Severe.” This blanket statement is followed by NCA5 Figure 2.7 (reproduced below) which shows the number of hot days, cold days and warm nights (respectively in panels a—c) over the period 2002-2021 compared to 1901-1960. [Presumably these are annual counts, although not stated in the caption.]



Close inspection shows that this figure contradicts the NCA5 Key Message with respect to heatwaves and instead reinforces the position of NCA4. Notwithstanding Key Message 2.2 the leftmost panel in Figure 2.7 above shows that over most of CONUS the number of extreme heat days has decreased in recent decades compared to the prior century.

The accompanying discussion in NCA5 becomes convoluted as it appears to be aimed at supporting the Key Message despite the contrary evidence. NCA5 chapter 2 elaborates on Key Message 2.2 by saying (page 16):

Observations show an increase in the severity, extent, and/or frequency of multiple types of extreme events. Heatwaves have become more common and severe in the West since the 1980s (*high confidence*).

But while it mentions the increase in hot days in the West NCA5 fails to mention the decrease everywhere east of the Rockies. On the next page (page 17) it raises the comparison to the 1930s then switches to discussing global counts:

By some measures, the most extreme heatwaves on record in the United States occurred during the Dust Bowl era of the 1930s. ... Globally such heatwaves are becoming more frequent, and in recent decades the western United States has been following those trends.

The reference to a global trend seems to be an attempt to tie heatwaves to anthropogenic climate change. But the obvious question, unaddressed by NCA5, is why one region follows the global pattern of increasing heatwaves while most of the country is trending in the opposite direction. These issues are addressed in Chapter 6 of CWG25, demonstrating that the range and magnitude of extreme temperatures (10s of degrees) are driven more by natural variability than by the small anthropogenic forcing. The analysis in CWG25 shows that for both (a) hot days ($\geq 95^{\circ}\text{F}$) and (b) number of days in heatwaves, the current decade is no hotter than a century ago in the U.S. Thus, the NCA5 claim that “multiday heatwaves have become hotter, more frequent, larger, and longer lasting in recent decades,” is simply false when expanding the temporal and spatial domains to encompass all available data (Chapter 6 and Figure 6.3.6 of CWG25).

NCA5 then pointed to the dramatic Pacific Northwest heatwave of 2021. CWG2025 Section 8.6.1 discussed this event in detail, reviewing the multiple peer reviewed studies that explained the unusual meteorological context was unrelated to human-caused climate change, a point omitted from the NCA5 discussion.

NCA5 finally addresses the declining heatwave trend in CONUS east of the Rockies but attempts to reframe it by focusing on urban warm spells.

[The] number of very hot days has actually decreased across the central and eastern regions due to summer cooling trends in the region (Figure 2.7; Ch. 22). This does not, however, mean the central and eastern US are not affected by heat. The impacts of extreme high temperatures are more severe if such conditions persist for several days, and overall, multiday heatwaves have become hotter, more frequent, larger, and longer lasting in recent decades. Across 50 large US cities, the US Global Change Research Program heatwave indicator (<https://www.globalchange.gov/indicators/heat-waves>) shows that the average number of heatwaves has doubled since the 1980s, and the length of the heatwave season has increased from about 40 days to about 70 days.

We discussed part of NCA5 in CWG25 Section 6.3. The figure referenced by NCA5 uses an *ad hoc* definition of heat wave, namely two consecutive days with minimum nighttime temperatures above the 85th percentile, and an *ad hoc* time scale which begins in the 1960s, the coldest decade in the last century, thus suppressing any comparison to the 1930s. Further, nighttime temperatures in urban areas have increased faster than daytime temperatures (which NCA5 acknowledges), but this is a signature of urban heat islands and not a good metric of climate change. CWG25 noted as well that the occurrence of hot days ($\geq 95^{\circ}\text{F}$) has recently increased in the West, but declined in the remainder of the country, and in the nationwide average, since 1899.

5 INADEQUATE TRACEABLE ACCOUNTS

NCA3 began the practice of including a section on Traceable Accounts at the end of each chapter. This is the description from NCA5:

Each chapter concludes with a section entitled Traceable Accounts, which provides information on the overall process used to develop the chapter as well as a separate Traceable Account section for each Key Message. These Traceable Accounts describe the supporting evidence behind each Key Message, the process and rationale authors used in reaching their conclusions, and the author team's expert assessment of the confidence in and, where applicable, likelihood of these conclusions. As such, Traceable Accounts provide information about the state of the science, document sources of uncertainty, identify research gaps, and allow traceability to data and resources.

The Traceable Accounts for each Key Message includes the following sections:

- Description of Evidence Base
- Major Uncertainties and Research Gaps
- Description of Confidence and Likelihood

The Traceable Accounts could have addressed the statutory requirement that the NCA discuss scientific uncertainties. They could also help satisfy the Executive Order for Restoring Gold Standard Science by addressing reproducibility, transparency, communication of error and uncertainty, and skepticism of findings and assumptions. However, the Traceable Accounts in NCA5's Chapters 2 and 3 are uneven, often superficial and uninformative.

An example of a deficient Traceable Account is NCA5's Key Message 2.2: "Extreme Events are Becoming More Frequent and Severe". The "Description of the Evidence Base" offers two paragraphs, the first summarizing the findings and the second generically describing the types of data that can be used for storms. "Major Uncertainties and Research Gaps" focuses on the uneven distribution across U.S. populations due to differences in exposure and vulnerability. The only limitations in data referred to are the lack of a long-term record of lightning and the lack of homogenized daily and hourly temperature data apart from reanalysis products.

But the most astonishing deficiency is in the "Description of Confidence and Likelihood." One of the statements in Key Message 2.2 is:

Hurricanes have been intensifying more rapidly since the 1980s (high confidence) and causing heavier rainfall and higher storm surges (high confidence).

The Description of Confidence and Likelihood includes the following statement:

Basic physical understanding and climate models both provide robust explanations for the links between climate change and observed changes in these extremes: this is why the authors also have high confidence that storms are delivering more rainfall and high confidence that storm surges are becoming higher.

No reference to journal publications or a specific data set is made anywhere in the Chapter regarding hurricane-induced precipitation or storm surge to support this *high confidence* conclusion.

The Traceable Accounts for the various Key Findings of Chapter 3 have some substantial inconsistencies. Consider

Key Message 3-1: Human activities have caused global warming.

Confidence and Likelihood: “There is *very high confidence* that emissions of GHGs from human activities, fossil fuel use in particular, have *unequivocally* caused all global warming observed over the industrial era. There is also *very high confidence* that changes in natural climate drivers have had globally small and regionally variable long-term effects over this period.”

The Uncertainties section addresses only uncertainties in radiative forcing by greenhouse gases. In contrast, the Traceability Analysis of Key Message 3-4 (“Humans Are Changing Earth System Processes”) raises the problem that relatively little is known about the role of natural variability at the regional scale. From its Description of Evidence Base:

In the last decade, there has been increasing recognition of the role of regional-scale natural variability in the past and future evolution of climate, as well as the fact that regional natural variability signals can be competitive with forced anthropogenic signals.

And from its Major Uncertainties and Research Gaps:

For example, the true natural variability of the climate system on decadal to centennial timescales could be larger than what we estimate from GCMs, which would further increase the irreducible uncertainty stemming from natural variability.

These statements are among the most scientifically credible in the entire NCA5 and they directly undercut the confidence assigned to Key Message 3-1.

There is also a generic problem in tracing NCA5’s Traceable Accounts. The Front Matter of NCA5 states:

Each figure and some tables are accompanied by a metadata survey, which can be accessed in the online version of the report by clicking on the eyeball icon above the figure or table (see the table below for explanations of additional icons used throughout the report). The metadata survey describes data sources, figure or table development methods, copyright information, and other important documentation.

Clicking on the eyeball icon does not reveal the metadata information, instead a “Contact Us” email appears, addressed to the USGCRP. This is clearly an inadequate way to archive the metadata information.

In summary, the Traceable Analyses examined here, with few exceptions, fail to meet the stated objectives set forward by the NCA.

6 OVEREMPHASIS ON EXTREME SCENARIOS

To respond to the GCRA mandate to “project major trends for the subsequent 25 to 100 years,” NCA5 relies on projections of future climate change based on estimates of future emissions (the so-called SSP scenarios) and/or specified levels of radiative forcing (the RCP scenarios). For the most part, NCA5 uses scenarios developed for the IPCC Assessment Reports.

In CWG Section 3.2.1 we presented a critical assessment of past and current IPCC scenario envelopes, showing that they have tended to overshoot observed emissions. The IPCC AR6 published in 2021 stated that "The likelihood of high-emission scenarios like RCP8.5 and SSP5-8.5 is considered low in light of recent energy sector developments." and that same year UN Climate Negotiators (COP) stopped using scenarios above 4.5.

NCA5 makes the following observations about the scenarios they use:

NCA5 authors were advised to assess the full range of scenarios available. (Front Matter)

Scenarios of future emissions and land-use change are developed as plausible alternatives, but no relative likelihood is attached to them. Some recent studies, however, have argued that the highest scenario, SSP5-8.5, is no longer plausible without a reversal of current trends in the adoption of renewables and energy efficiency. (Key Message 3.3 Traceable Analysis)

Despite acknowledging the issue, NCA5 otherwise ignored the problem. A keyword search of NCA5 of mentions of RCP/SSP scenarios finds over 50% referred to the extreme emissions scenarios RCP8.5/SSP5-8.5. Further, nine NCA5 figures (5.2, 6.9, 7.4, 11.3, 14.6, 22.13, 22.19, 27.9, 29.13) included *only* the 8.5 scenarios.

The problem of relying on extreme scenarios is particularly acute for NCA5's sea level rise projections. The sea level rise scenarios used in NCA5 do not relate directly to the SSP emissions scenarios, but rather to specified amounts of sea level rise by 2100. Table 4 of NCA5's "Guide to Using this Report" reproduced below shows that Low relates to 0.3 m (0.98 feet), Intermediate-Low relates to 0.5 m (1.64 feet), Intermediate relates to 1.0 m (3.28 feet), Intermediate-High relates to 1.5 m (4.92 feet), and High relates to 2.0 m (6.56 feet).

Table 4. Descriptive Terms for Common Sea Level Rise Scenarios Used in NCA5						
Future global mean sea level rise and sea level rise along United States coastline are shown for five scenarios in feet (and meters), relative to a 2000 baseline. The US values shown in the right half of the table are averaged across the US coastal regions, including the contiguous US, Alaska, Hawaii and the US-Affiliated Pacific Islands, and the US Caribbean. The national values shown in the table differ substantially from regional values. For example, sea level rise is higher in the Gulf Coast and lower or even negative in some parts of Alaska. In the next 30 years (2020–2050), sea level along the contiguous US coasts is expected to rise 0.92 feet (0.28 m), the same amount of sea level rise observed over the last 100 years (1920–2020). See Chapter 3 for regional sea level information. Adapted from Sweet et al. 2022. ⁹						
Sea Level Rise Scenario Descriptor	Global Mean Sea Level			United States		
Year	2050	2100	2150	2050	2100	2150
Low	0.49 (0.15)	0.98 (0.3)	1.31 (0.4)	0.59 (0.18)	0.98 (0.3)	1.64 (0.5)
Intermediate-Low	0.66 (0.20)	1.64 (0.5)	2.62 (0.8)	0.75 (0.23)	1.64 (0.5)	2.95 (0.9)
Intermediate	0.92 (0.28)	3.28 (1.0)	6.23 (1.9)	0.89 (0.27)	3.28 (1.0)	6.89 (2.1)
Intermediate-High	1.21 (0.37)	4.92 (1.5)	8.86 (2.7)	1.12 (0.34)	4.92 (1.5)	8.86 (2.7)
High	1.41 (0.43)	6.56 (2.0)	12.14 (3.7)	1.38 (0.42)	6.56 (2.0)	12.46 (3.8)

Table 4 from the Front Matter of NCA5

Considering only projections representing processes quantified with at least medium confidence, IPCC AR6 assessed global mean sea level projections for 2100 to fall between 0.2 and 1.6 m (5th—95th percentile range). Nevertheless, the range of sea level rise scenarios considered by NCA5 extends to 2.0 m. Further, NCA5 fails to include plausible lower scenarios, such as 0.2 m cited by the IPCC, which also corresponds to the average rate of sea level rise over the past century.

Chapter 9 of NCA5 offers the following predictions of sea level rise:

“Under a range of potential global warming levels, average sea level along US coastlines is *likely* to be between 12 and 20 inches above 2000 sea levels in 2050 (Figure 9.2).”

These values span from the Intermediate scenario to values slightly greater than the High scenario. They can be put into context by considering the observed global sea level rise from 2000-2024, approximately 3.39 inches (0.28 feet). NCA5 is thus projecting a sea level rise during 2025 and 2050 that is 3.5 to 5.8 times the rate observed during 2000-2024, an exceedingly implausible outcome. Chapter 9 further states:

“Looking toward the future, an 11 inch (28 cm) average rise along the contiguous US coastline is expected by 2050 (relative to 2020), with a *likely* range of 9-13 inches.”

...
“There is *high confidence* and it is *likely* that sea levels will rise about 11 inches (likely range of about 9–13 inches) between 2020 and 2050”

In summary, NCA5 presents future sea level rise scenarios that are not directly relatable to either SSP/RCP emissions scenarios nor to global warming levels. The NCA5 scenarios include two scenarios that are higher than the 95th percentile for the extreme emissions scenario RCP8.5 and include hypothesized ice sheet processes in which there is low confidence. Projections to 2050 require rates of sea level rise from 2025 to 2050 that are more than triple the rate observed during 2000-2024. Further, NCA5 ascribes *high confidence* to these sea level rise projections. CWG25 Section 7.3 provides further context for USGCRP projections of extraordinary sea level rise in the next 25 years.

More generally, NCA5’s inclusion, and even focus, on implausible extreme emissions scenarios supports projections of alarming impacts that are very unlikely to be driven by anthropogenic warming.

7 INADEQUATE NASEM REVIEW: TO BE ADDED

I THINK WE SHOULD DELETE THIS CHAPTER, IT ISN’T VERY STRONG

The National Academies of Science, Engineering and Medicine (NASEM) undertook a detailed review of the draft NCA5 (NASEM 2023). While they raised some of the same concerns that we have articulated herein, their review is superficial overall and appears to be written by authors who share many of the biases of the NCA5 team. There is an inordinate focus on social and policy issues (e.g., every chapter is assessed under the heading “Comments on Equity and Justice”), rather than on the underlying science. In our assessment NASEM failed to apply the serious rigor one would expect. A few extracted comments from it will illustrate. Note that NASEM review comments are included here in blue font for reference.

7.1 Substantive criticisms by NASEM

- summarize the valid points made by NASEM and check the NCA replies

7.2 Failures to challenge NCA5 flaws

NASEM praised Chapter 2, saying:

The chapter [2] meets the requirements of Section 106 of the GCRA.

Yet contrary to the requirements of Section 106, Chapter 2 did not adequately discuss natural variability let alone assess the full climate record available for quantifying natural variability. Chapter 2 actually minimizes natural variability by claiming (unsubstantiated) skill in attributing recent extremes to human causes. For example NCA5's Chapter 2 Introduction states,

"...recent advances in attribution science (KM 3.3) mean that the role of climate change in some extreme events can now be quantified in real time. For example, climate change made the record-breaking Pacific Northwest heatwave of June 2021 2° to 4°F hotter, and in 2017 ..."

CWG25 reviews the expert literature demonstrating that this particular event would have happened with or without climate change and that for CONUS, hot extremes are no more frequent now than they were in the past. NASEM did not challenge the unsubstantiated attribution claims in NCA5.

Notwithstanding NASEM's claim that the Chapter complies with Section 106 of the GCRA, it then acknowledged the absence of discussion of natural variability:

...the discussion and references regarding the role of natural climate variability and its regional differences are missing.

While a nod to natural variability is occasionally found in NCA5, it is usually followed by a "however" to emphasize human influence. One example is the statement just before the claim mentioned above pertaining to extreme event attribution: "There has always been extreme weather, which occurs even in an unchanged climate due to the natural variability of the Earth system. However, recent advances in attribution science (KM 3.3) mean that the role of climate change in some extreme events can now be quantified in real time..."

We pointed out (Section 4.2) that the evidence regarding heatwaves directly contradicts Key Message 2.2. NASEM did not mention this, instead it focused on a somewhat esoteric issue of terminology:

"Extreme Events Are Becoming More Frequent and Severe."

Key Message 2.2 is another generally well written key message. However, while the title of this key message includes the word "risk," the key message is exclusively about hazard. The Committee suggests rewriting the key message title to more accurately reflect the discussion on hazards.

The NASEM review appears to accept NCA5's use of short data records because it makes no critical remarks about the failure to assess long time series, except for its observation that the use of short records makes the omission of natural variability that much more of a problem:

It is also important to point out that the influence of natural climate variability becomes particularly strong when the climate trend is computed based on short periods of time or small geographic areas.

This comment was largely ignored in the NCA5 final text.

In sum, while the NASEM review might bestow the Academies' imprimatur on the NCA5 report, it does not necessarily add to its quality for two reasons. As we have demonstrated, the NASEM review falls short in rigor and completeness. And second, the NCA authors are not obligated to follow the NASEM recommendations in crafting their final product.

8 SUMMARY EVALUATION OF NCA5

whether NCA5: (1) complied with the USGCRP's statutory obligation, (2) adheres to the core tenets of Gold Standard Science, and (3) can suitably inform federal climate and energy policy.

The most straightforward evaluation of NCA5 is through its statutory requirements. While it is not within our purview to make definitive rulings on compliance, we believe there are several important aspects to consider when evaluating NCA5 against its statutory requirements. Add text per Seth's letter ...

~~Our expertise in climate science, the foundational area covered by NCA5, allows a different perspective, one that finds the coverage unbalanced and selective. Our review has identified numerous instances where NCA5 falls short of the quality and integrity expected of scientific document of this importance. Furthermore, our examination suggests that the entire process—from the selection of contributing authors to the handling of expert reviews—appears to have been systematically biased toward reinforcing predetermined conclusions and amplifying alarmist messaging rather than presenting a balanced scientific assessment. In short, NCA5 was written to persuade, not inform.~~

~~A third perspective for evaluating NCA5 is that of citizens interested in good policymaking. The changing climate is a legitimate public concern, as are concerns about cost of living, economic growth, employment opportunities, and other socioeconomic factors. We share the widespread belief that elected officials should have access to the highest quality information when crafting energy and climate policy decisions that must balance multiple concerns. From this perspective, NCA5 is a missed opportunity. What could have been a valuable contribution to informed tradeoffs instead became a misleading advocacy document that corrupts the policymaking process.~~

The National Academies of Science, Engineering and Medicine (NASEM) undertook a detailed review of the draft NCA5 (NASEM 2023). While they raised some of the same concerns that we have articulated herein, their review is superficial overall and appears to be written by authors who share many of the biases of the NCA5 team. There is an inordinate focus on social and policy issues (e.g., every chapter is assessed under the heading “Comments on Equity and Justice”), rather than on the underlying science. In our assessment NASEM failed to apply the serious rigor one would expect. A few extracted comments from it will illustrate. Note that NASEM review comments are included here in blue font for reference.

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APPENDICES

APPENDIX 1: Charge to the review

APPENDIX 2: Reproducibility of NCA5 claim of extreme precipitation trends

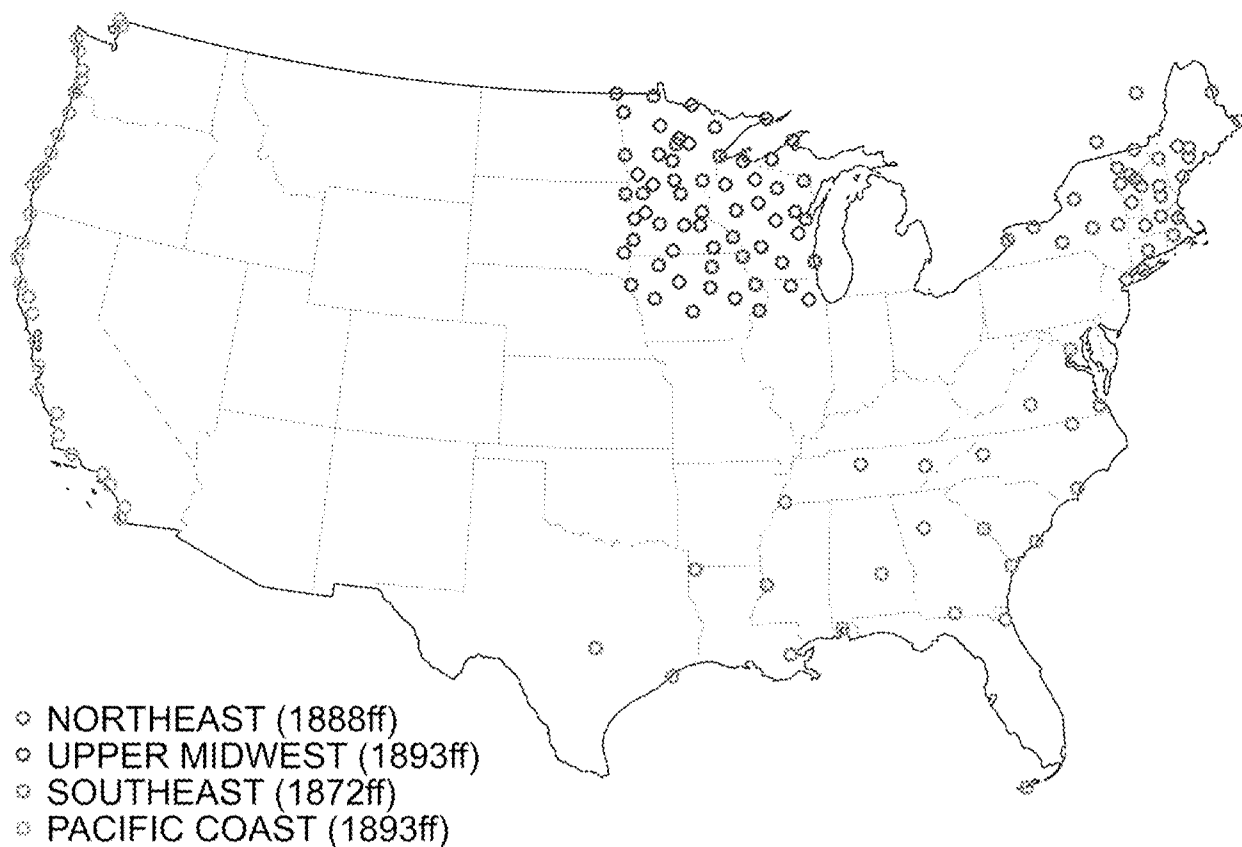


Figure A1: Stations used in the following analyses

Note: All data are available at Christy (2025). Methods as described in McKittrick and Christy (2019), code available at McKittrick and Christy (2025).

Table codes: (-) neg insignificant, -- neg significant, (+) pos insignificant, ++ pos significant.

Column 1: Measure

Column 2: Number of stations in that region

Column 3: Count of stations exhibiting a significant positive trend

Column 3: Count of stations exhibiting a significant negative trend

Column 5: Characteristic of region-wide trend

PACIFIC COAST

Since 1893:

	No. stns	+ trends	- trends	region
1-day average	29	0	1	(-)
2-day average	29	0	1	(-)
Avg on non-zero days	29	0	9	--
Variability	29	1	0	(+)
Annual max	29	2	1	(+)
Number of 99 th pct exceedances	29	1	0	(-)

Since 1950:

	No. stns	+ trends	- trends	region
1-day average	29	0	1	(-)
2-day average	29	0	1	(-)
Avg on non-zero days	29	0	4	(-)
Variability	29	2	3	(-)
Annual max	29	6	3	(-)
Number of 99 th pct exceedances	29	2	1	(-)

Since 1980:

	No. stns	+ trends	- trends	region
1-day average	29	0	0	(-)
2-day average	29	0	0	(-)
Avg on non-zero days	29	0	1	(-)
Variability	29	0	0	(-)
Annual max	29	2	1	(-)
Number of 99 th pct exceedances	29	0	0	(+)

SOUTHEAST

Since 1873:

	No. stns	+ trends	- trends	region
1-day average	24	1	1	(+)
2-day average	24	1	1	(+)
Avg on non-zero days	24	7	2	(+)
Variability	24	1	0	(+)
Annual max	24	2	0	(+)
Number of 99 th pct exceedances	24	5	0	(+)

Since 1950:

	No. stns	+ trends	- trends	region
1-day average	24	5	0	++
2-day average	24	5	0	++
Avg on non-zero days	24	5	1	++
Variability	24	6	0	++
Annual max	24	4	0	++
Number of 99 th pct exceedances	24	4	0	(+)

Since 1980:

	No. stns	+ trends	- trends	region
1-day average	24	5	0	(+)
2-day average	24	5	0	(+)
Avg on non-zero days	24	5	1	(+)
Variability	24	3	0	(+)
Annual max	24	4	0	(+)
Number of 99 th pct exceedances	24	4	0	(+)

MIDWEST

Since 1893:

	No. stns	+ trends	- trends	region
1-day average	61	23	0	++
2-day average	61	23	0	++
Avg on non-zero days	61	2	12	(+)
Variability	61	12	0	++
Annual max	61	9	0	(+)
Number of 99 th pct exceedances	61	10	0	(+)

Since 1950:

	No. stns	+ trends	- trends	region
1-day average	61	28	2	++
2-day average	61	28	2	++
Avg on non-zero days	61	11	1	++
Variability	61	16	0	(+)
Annual max	61	8	0	(+)
Number of 99 th pct exceedances	61	19	0	++

Since 1980:

	No. stns	+ trends	- trends	region
1-day average	61	6	1	(+)
2-day average	61	6	1	(+)
Avg on non-zero days	61	8	2	(+)
Variability	61	5	1	(+)
Annual max	61	0	1	(+)
Number of 99 th pct exceedances	61	5	3	(-)

NORTHEAST

Since 1888:

	No. stns	+ trends	- trends	region
1-day average	27	12	0	++
2-day average	27	12	0	++
Avg on non-zero days	27	7	1	(+)
Variability	27	4	0	(+)
Annual max	27	3	0	(-)
Number of 99 th pct exceedances	27	5	0	(+)

Since 1950:

	No. stns	+ trends	- trends	region
1-day average	27	12	0	++
2-day average	27	12	0	++
Avg on non-zero days	27	7	1	(+)
Variability	27	4	0	(+)
Annual max	27	3	0	(-)
Number of 99 th pct exceedances	27	5	0	++

Since 1980:

	No. stns	+ trends	- trends	region
1-day average	27	10	1	++
2-day average	27	10	1	++
Avg on non-zero days	27	6	0	(+)
Variability	27	2	0	(+)
Annual max	27	1	0	(+)
Number of 99 th pct exceedances	27	1	1	++

ABOUT THE AUTHORS

[Insert updated bios]

DOCUMENT WITHHELD FOR PRIVILEGE

From: John Christy <climateman60@gmail.com>
Sent: Monday, July 7, 2025 2:52 PM
To: Ross McKitrick
Cc: Judith Curry; Roy W. Spencer; Steven Koonin; Travis Fisher; Josh Loucks; Cohen, Seth
Subject: Re: Texas Floods

Ross

Pielke Jr.s substack has some good info on past events, including a paper in 1940 that specifically indicated the high flooding potential of the TX Hill Country.

John C.

On Mon, Jul 7, 2025 at 11:49 AM Ross McKitrick <ross.mckitrick@gmail.com> wrote:

Here is a draft section on the Texas Floods. There are indicated sub-headings for detailed info on the local geography and the timeline of events. Roy maybe you could write something on those, and John and Judy will likely have info to add as well.

There is a snarky line or two which I expect Judy will cross out but enjoy them in the meantime. It's quite something what garbage NCA5 is.

I re-did the Austin precip results. In the process I realized I had multiplied some series by 100 to make the tables and figures in our JHydrol paper look better. It doesn't affect any of the sign or significance calculations in our trend tables, just trend units. So I've tidied all that up and re-generated all the results for the CWG25 and NCA reports. I'll make those amendments either later today or in the next few days before I forget. I'll have to post a new Mendeley archive which is a pain.

We head out tomorrow morning from Guelph to Lansing overnight then on to Chicago on Wednesday. No sign of baby Rowan yet, we likely have a few days to get there and get unpacked.

From: Ross McKittrick [ross.mckittrick@gmail.com]
Sent: 7/7/2025 4:49:34 PM
To: Judith Curry [curry.judith@gmail.com]; Roy W. Spencer [roywspencer@hotmail.com]; John Christy [climateman60@gmail.com]; Steven Koonin [steven.koonin@gmail.com]; Travis Fisher [travis.scott.fisher@gmail.com]; Josh Loucks [loucksj14@gmail.com]; Cohen, Seth [seth.cohen@hq.doe.gov]
Subject: Texas Floods
Attachments: NCA-TxFloods.[RM].July07.docx

Here is a draft section on the Texas Floods. There are indicated sub-headings for detailed info on the local geography and the timeline of events. Roy maybe you could write something on those, and John and Judy will likely have info to add as well.

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NCA5 and the July 2025 Kerrville Flash Flood Disaster

Introduction

In July 2025 a sudden flash flood devastated the region of Kerrville TX causing over 80 deaths and massive local damage. The Guadalupe River rose over 30 feet in xx hours following the landfall of Tropical Storm Barry on July xx. When tragic weather events occur many questions arise: Did forecasters, including the National Weather Service, give adequate warning? Could the loss of life have been prevented? Are existing flood control measures adequate? Nowadays some climate-related questions also arise: Are such events becoming more common or more severe? Are they being made worse by anthropogenic emissions of GHGs? If so, does this change how we should adapt and mitigate risks in the future?

There is an unfortunate tendency on the part of some observers to try to blame such disasters on greenhouse gases, as if to suggest that a specific weather event would not have happened if only governments had adopted more aggressive climate mitigation policies. This involves chains of hypothetical reasoning that go far beyond what science can establish and is unproductive for the purpose of helping society deal optimally with climate risks.

In this section we ask whether NCA5 played a constructive role in helping weather and disaster planning authorities in Texas mitigate the harm from the 2025 floods. NCA5 authors made the decision to address extreme weather at length; our question is whether they did so in a way that provided actionable information and useful guidance, bearing in mind that planning authorities need to allocate scarce resources. Funds allocated to one type of potential hazard in one location are unavailable for mitigating another hazard elsewhere. While it is worth trying to determine if trends are detectable and whether GHGs may contribute to the frequency or severity of weather disasters, making such a determination does not automatically imply that the NCA should advocate for adoption of renewable energy or any other emission mitigation options. Doing so impinges on decision-making by specialized planning bodies. If the ultimate goal is prevention of harm and preservation of lives, resources might be better spent on, for instance, upgrading dam and drainage infrastructure, improving warning systems and evacuation protocols, etc. Such decisions need to be made by competent local authorities once they have the best possible information at their disposal.

An NCA, if done well, can provide some of that information. Unfortunately, while NCA4 went part way towards that goal, NCA5 failed badly. A local authority looking to it for guidance would have found it worse than useless. It declares all climate threats to be getting worse, making it impossible to set planning priorities. It provided only cursory treatment of adaptation options and relentlessly advocated for adopting renewables. Thus, it sought to persuade rather than inform, making it unreliable as a decision-support asset.

Geographical and meteorological aspects of the flood

- Details about the region and the known weather risks

Timeline of events

- NWS warnings; local responses or lack thereof

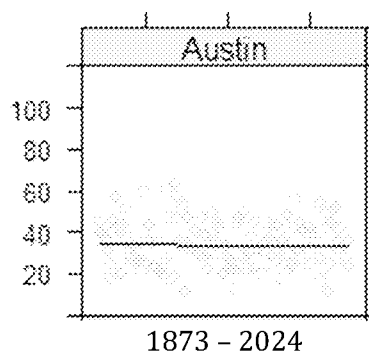
Rainfall data summary for Austin TX

Our trend analysis (McKittrick and Christy 2025) for the nearby Austin TX monitoring station, which provides daily records from 1873 to 2025, show the following.

Metric	Start year	Trend	CI lower	CI upper	Sig (5%)
1-day total	1873	-0.006	-0.051	0.040	0
	1950	0.084	0.000	0.168	1
	1980	0.064	-0.142	0.270	0
2-day total	1873	-0.006	-0.102	0.080	0
	1950	0.168	0.000	0.336	1
	1980	0.128	-0.285	0.540	0
Average on non-zero days	1873	-0.001	-0.003	0.000	0
	1950	0.001	0.000	0.002	0
	1980	0.002	0.000	0.003	1
Variance	1873	-0.019	-0.065	0.026	0
	1950	0.052	-0.002	0.107	0
	1980	0.075	-0.094	0.245	0
Annual maximum	1873	-0.004	-0.013	0.005	0
	1950	0.011	-0.002	0.024	0
	1980	0.014	-0.030	0.057	0
Annual 99 th percentile exceedances	1873	-0.008	-0.017	0.002	0
	1950	0.008	-0.020	0.035	0
	1980	0.028	-0.027	0.084	0

Table: trends in various rainfall metrics for Austin TX from indicated start year to 2024. Trend units for 1- and 2-day totals and average on non-zero days: inches per year; Variance: squared inches, Annual maximum: inches per year. Annual 99th pctlle exceedances: event counts. CI denotes 95% Confidence Interval bounds. Sig (5%): statistically significant at 5%, 0=No, 1=Yes.

Annual Total Precipitation (inches):

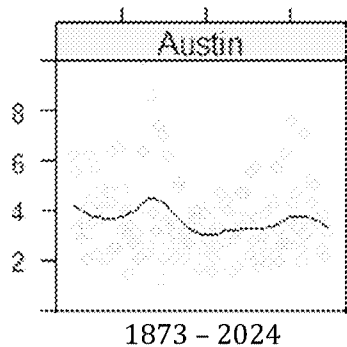


1-day and 2-day totals: The trends over 1873-2024 are negative and insignificant, they become positive and significant over 1950-2024 then shrink slightly and become insignificant again after

1980. There were more years of higher overall average rainfall early in the sample. Also, if the post-1950 trend were driven by global warming it should intensify after 1980 rather than weaken. For average rainfall on non-zero days the trend is negative and insignificant 1873-2024 then becomes positive post-1950 but remains small and insignificant.

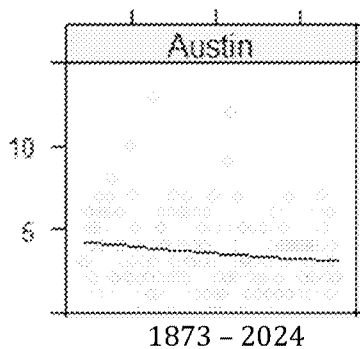
The trend in the annual rainfall variance is negative and insignificant 1873-2024 and positive and insignificant post-1950.

Annual maximum rainfall:



The trend in the annual maximum rainfall is negative and insignificant 1873-2024 then becomes positive post-1950 but remains small and insignificant. Post 1980 the trend is +0.014 inches per year.

Annual 99th percentile exceedances:



The trend in the number of annual exceedances of the sample 99th percentile rainfall total is negative and insignificant 1873-2024 then becomes positive post-1950 but remains small and insignificant.

In summary the regional precipitation data does not point to an increasing trend in overall annual rainfall or in metrics of extreme precipitation or variability. Likewise, streamflow records show no evidence that floods in the area are becoming more or less common. The planning focus should be on understanding and preparing for the potential weather-related risks as revealed by historical data. This includes the full potential range of flood characteristics on major floodplains in the area especially in the aftermath of landfalling tropical storms.

NCA4 makes statements consistent with these findings, although with less detail. It admitted that regional precipitation trends are unclear. It notes a decreasing trend in summertime extratropical cyclone activity across North America since 1979 (p. 213) but evidence of increasing episodes of extreme rainfall from U.S. landfalling tropical cyclones (p. 214). It notes that precipitation trends are not clearly attributed to anthropogenic forcing (pp. 213-214) and there is low confidence in attribution. It states that there is no robust evidence that trends are attributable to human activities (p. 240) and that increases in flooding rates are detected only in 1/3 of locations in central US (p. 240-241). Finally it states

[In] U.S. regions, no formal attribution of precipitation changes to anthropogenic forcing has been made so far, so indirect attribution of flooding changes is not possible. Hence, no formal attribution of observed flooding changes to anthropogenic forcing has been claimed. (NCA4 p. 241)

This would support a conclusion that the focus of resource allocation should be adaptation to the known current risk profiles of each region and that there is little to be gained by trying to forecast changes under greenhouse forcing, nor would GHG emission reductions be an effective way to reduce future flood risks.

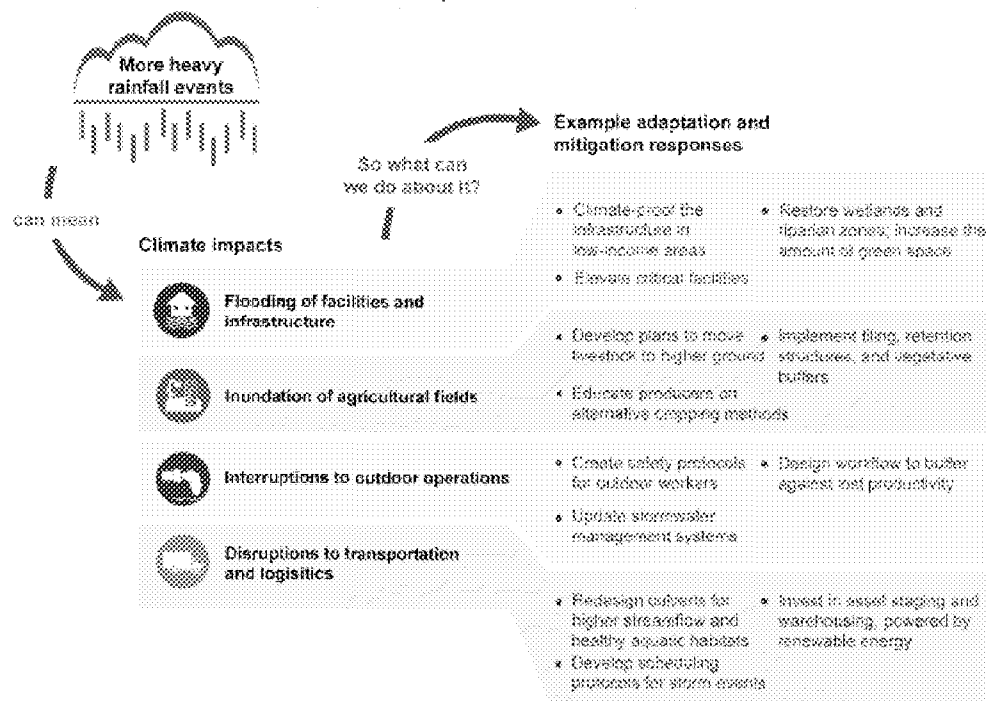
NCA5 as a planning tool

Does NCA5 contain information that would have been of any use to regional planners? No, we judge it to have been worse than useless. It presents no data on precipitation patterns and no information on the nature of specific potential hazards in “flash flood ally” or other high-risk areas, and it makes sweeping unsubstantiated claims to the effect that every climate risk is getting worse over time. For example, in Chapter 26 (Southern Great Plains) the first Key Message is (p. 26-7):

Climate change is beginning to alter how we live in the Southern Great Plains, putting us at risk from climate hazards that degrade our lands and waters, quality of life, health and well-being, and cultural interconnectedness (*high confidence*). Many climate hazards are expected to become more frequent, intense, or prolonged; to broaden in spatial extent; and to result in more people experiencing costly, deadly, or stressful climate-related conditions (*very likely, high confidence*). To address the growing risk, effective climate-resilient actions include implementing nature-based solutions; valuing Indigenous, traditional, and local knowledges; and infusing climate change solutions into community planning (*medium confidence*).

The tone is that of a mediocre student struggling to write an essay on a topic he has never studied. By saying every hazard is getting worse the document is both inaccurate and useless for local authorities who must set priorities and make resource allocation decisions. The same chapter presents rainfall projections through the mid-21st century (Figure 26.10) that imply drying throughout southern TX, but no explanation is given as to how this reconciles with projections of increasing extreme precipitation in the same region (Figure 2.12 p. 2-25) or the lack of observed trends either way. The first discussion of regional trends in heavy rainfall events is on page 26-22 which focuses entirely on sports teams having to move events indoors which results in “increasing participation costs and decreasing access to sports, especially for lower-income populations.” Their adaptation advice consists of the following cartoon on page 26-19:

Resilience Actions to Address the Impacts of Heavier Rainfall Events on Businesses



Resilience actions can help businesses and industries reduce the negative consequences of more heavy rainfall events.

Figure 26.11. An increased number of heavy rainfall events affects business and industry across the Southern Great Plains through flooding of facilities and infrastructure, inundation of agricultural fields, interruptions to outdoor operations, and disruptions to transportation and logistics. The example adaptation and mitigation actions can increase resilience and reduce negative impacts. Figure credit: See figure metadata for contributors.

Figure: screenshot of NCA5 Figure 26.11

Once again, the advice is so vacuous it could have been written by someone who has never studied the topic. Combined with its pervasive advocacy for renewable energy NCA5 is worse than simply unhelpful: if planners based serious decisions on it they would misallocate scarce resources away from beneficial measures towards worthless ones, to the detriment of the U.S.

A well-constructed NCA6 could contribute to climate risk management by providing accurate and objective information on specific and predictable local risks, such as flash floods in TX, wildfires in CA, hurricanes in FL, etc. NCA6 should canvass relevant historical data and describe key baseline metrics related to extreme weather. It should identify where there are trends while being honest and transparent about uncertainties. It should be written with a view to serving the needs of decision-makers charged with allocating resources for risk management.

From: Ison, Jeremy T. <jeremy.ison@hq.doe.gov>
Sent: Friday, August 8, 2025 5:18 PM
To: Steven Koonin; 'John Christy'; 'Ross McKittrick'; 'Judith Curry'; 'Roy W. Spencer'
Subject: Introductory Call

All,

Thank you for your patience as I take on this coordination role at DOE.

I would like to set up an introductory call for mid-next week to introduce myself and discuss next steps.

Going forward, please treat me as your single point of contact for DOE.

I'm looking forward to working with you all.

Thank you,
Jeremy Ison

From: Ross McKittrick [ross.mckittrick@gmail.com]
Sent: 7/15/2025 4:46:16 PM
To: Travis Fisher [travis.scott.fisher@gmail.com]; Cohen, Seth [seth.cohen@hq.doe.gov]; Josh Loucks [loucksj14@gmail.com]; John Christy [climatemanager60@gmail.com]; Judith Curry [curry.judith@gmail.com]; Roy W. Spencer [roywspencer@hotmail.com]; Steven Koonin [steven.koonin@gmail.com]
Subject: 11:45 AM version - use this instead
Attachments: DoE.Report.July15.FOR_DoE_REVIEW.pdf; DoE.Report.July15.FOR_DoE_REVIEW.docx

slight revision in one glossary entry.



Impacts of Carbon Dioxide Emissions on the U.S. Climate

Climate Working Group

United States Department of Energy

July 15, 2025

Impacts of Carbon Dioxide Emissions on the U.S. Climate

Report to U.S. Energy Secretary Christopher Wright

July 15, 2025

Climate Working Group:

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SECRETARY’S FOREWORD

Energy, Integrity, and the Power of Human Potential

Over my lifetime, I’ve had the privilege of working as an energy entrepreneur across a range of fields—nuclear, geothermal, natural gas, and more—and I now serve as Secretary of Energy under President Donald Trump. But above all, I’m a physical scientist who sees modern energy as nothing short of miraculous. It powers every aspect of modern life, drives every industry, and has made America an energy powerhouse with the ability to fuel global progress.

The rise of human flourishing over the past two centuries is a story worth celebrating. Yet we are told—relentlessly—that the very energy systems that enabled this progress now pose an existential threat. Hydrocarbon-based fuels, the argument goes, must be rapidly abandoned or else we risk planetary ruin.

That view demands scrutiny. That’s why I commissioned this report: to encourage a more thoughtful and science-based conversation about climate change and energy. With my technical background, I’ve reviewed reports from the Intergovernmental Panel on Climate Change, the U.S. government’s assessments, and the academic literature. I’ve also engaged with many climate scientists, including the authors of this report.

What I’ve found is that media coverage often distorts the science. Many people—even well-meaning ones—walk away with a view of climate change that is exaggerated or incomplete. To provide clarity, I asked a diverse team of independent experts to summarize the current state of climate science, with a focus on how it relates to the United States.

I didn’t select these authors because we always agree—far from it. In fact, they may not always agree with each other. But I chose them for their rigor, honesty, and willingness to elevate the debate. I exerted no control over their conclusions. What you’ll read are their words, drawn from the best available data and scientific assessments.

I’ve reviewed the report carefully and challenged its findings. I believe it faithfully represents the state of climate science today. Still, many readers may be surprised by its conclusions—which differ in important ways from the mainstream narrative. That’s a sign of how far the public conversation has drifted from the science itself.

To correct course, we need open, respectful, and informed debate. That’s why I’m inviting public comment on this report. Honest scrutiny and scientific transparency should be at the heart of our policymaking.

Climate change is real, and it deserves attention. But it is not the greatest threat facing humanity. That distinction belongs to global energy poverty. As someone who values data, I know that improving the human condition depends on expanding access to reliable, affordable energy. Climate change is a challenge—not a catastrophe. But misguided policies based on fear rather than facts could truly endanger human well-being.

We stand at the threshold of a new era of energy leadership. If we empower innovation rather than restrain it, America can lead the world in providing cleaner, more abundant energy—lifting billions out of poverty, strengthening our economy, and improving our environment along the way.

EXECUTIVE SUMMARY

This report reviews scientific certainties and uncertainties in how anthropogenic carbon dioxide (CO₂) emissions have affected, or will affect, the Nation's climate, extreme weather events, and selected metrics of societal well-being. Those emissions are increasing the concentration of CO₂ in the atmosphere through a complex and variable carbon cycle, where some portion of the additional CO₂ persists in the atmosphere for centuries.

Elevated concentrations of CO₂ directly enhance plant growth, globally “greening” the planet and increasing agricultural productivity. They also make the oceans less alkaline (lower the pH) by an amount within the range of natural variability. That is possibly detrimental to coral reefs, although the recent rebound of the Great Barrier Reef suggests otherwise.

Carbon dioxide also acts as a greenhouse gas, exerting a warming influence on climate and weather. Scenarios of future CO₂ emissions have tended to overestimate observed levels.

The world's several dozen detailed climate models offer little guidance on how the climate responds to elevated CO₂, with the average surface warming under a doubling of the CO₂ concentration ranging from 1.8°C to 5.7°C, a larger range than data driven estimates that suggest a response in the range 1.8°C to 2.7°C.

Detailed climate models generally run “hot” in their description of the climate of the past few decades - too much warming at the surface and too much amplification of warming in the lower- and mid-troposphere. They also produce too much stratospheric cooling, too much snow loss, and too much warming in the U.S. Corn Belt. The combination of overly sensitive models and extreme scenarios for future emissions has exaggerated projections of future warming.

Most extreme weather events do not show long-term trends. Claims of increased frequency or intensity of hurricanes, tornadoes, floods, and droughts are not supported by historical data. Additionally, forest management practices are often overlooked in assessing wildfire activity. Global sea level has risen approximately 8 inches since 1900, but there are significant regional variations in tide gauge data driven primarily by local land subsidence; U.S. tide gauge measurements in aggregate show no obvious acceleration in sea level rise beyond the historical average rate.

The attribution of particular climate changes or extreme weather events to human CO₂ emissions is challenged by natural climate variability, data limitations, and inherent model deficiencies. Moreover, solar activity's contribution to the late 20th century warming might be underestimated.

Both models and experience suggest that CO₂-induced warming might be less damaging economically than commonly believed, and excessively aggressive mitigation policies could prove more detrimental than beneficial. Social Cost of Carbon estimates, which attempt to quantify the economic damage of CO₂ emissions, are highly sensitive to their underlying assumptions and so provide limited independent information.

The report supports a more nuanced and evidence-based approach for informing climate policy. The risks and benefits of a climate changing under both natural and human influences must be weighed against the costs, efficacy, and collateral impacts of any “climate action”, considering the nation's need for reliable and affordable energy with minimal local pollution. Beyond continuing precise, un-interrupted observations of the global climate system, it will be important to make realistic assumptions about future emissions, re-evaluate climate models to address biases and uncertainties, and clearly acknowledge the limitations of extreme event attribution studies. An approach that acknowledges both the potential risks and benefits of CO₂, rather than relying on flawed models and extreme scenarios, is essential for informed and effective decision-making.

PREFACE

This document originated in late March 2025 when Secretary Wright assembled an independent group to write a report on issues in climate science relevant for energy policymaking, with particular focus on the question of whether carbon dioxide emissions endanger the U.S. public. We agreed to undertake the work on the condition that there would be no editorial oversight by the Secretary, the Department of Energy, or any other government personnel. This condition has been honored throughout the process and the writing team has worked with full independence.

The group began working in early April with a deadline of May 28. The short timeline and the technical nature of the material meant that we could not comprehensively review all topics. Rather, we chose to focus on topics that are treated by a serious, established academic literature; that are relevant to our charge; that are downplayed in, or absent from, recent assessment reports; and that are within our competence.

While the report is intended to be accessible to non-experts, we have omitted some introductory or explanatory material that can easily be accessed elsewhere. Nor have we attempted to survey entire literatures related to the topics covered. We have focused as much as possible on literature published since 2020 and referenced previous IPCC and NCA assessment reports. We have also used data through 2024 where possible.

The writing team is grateful to Secretary Wright for the opportunity to prepare this report and for his support of independent scientific assessment and open scientific debate.

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Steven Koonin, Ph.D.

Ross McKittrick, Ph.D.

Roy Spencer, Ph.D.

**PART I: DIRECT HUMAN INFLUENCE ON ECOSYSTEMS AND THE
CLIMATE**

1 CARBON DIOXIDE AS A POLLUTANT

Chapter summary:

Carbon dioxide (CO₂) differs in many ways from the so-called Criteria Air Pollutants. It does not affect local air quality and has no human toxicological implications at ambient levels. It is an issue of concern because of its potential effects on the global climate, a complex issue that occupies much of this report.

The Clean Air Act of 1970 defined six so-called Criteria Air Contaminants subject to regulation (EPA): particulate matter, ground-level ozone, sulfur dioxide, nitrogen dioxide, lead, and carbon monoxide. In 2007, the Supreme Court ruled that greenhouse gases (CO₂ among them) were also “pollutants” subject to regulation under Clean Air Act (*Mass. v. EPA*, 2007). While the definition of “pollutant” is ultimately a legal matter, there are important scientific distinctions between CO₂ and the Criteria Air Contaminants. The latter are subject to regulatory control because they cause local problems depending on concentrations that include nuisances (odor, visibility), damage to plants, and, at high enough exposure levels, toxicological effects in humans. In contrast, CO₂ is odorless, does not affect visibility and has no toxicological effects at ambient levels. It is a naturally occurring part of the atmosphere and a key component of human and plant respiration. CO₂ is essential for plant photosynthesis and higher levels are beneficial for vegetation. In these aspects, CO₂ is similar to water vapor.

Ambient outdoor air today contains about 430 parts per million (ppm) CO₂, increasing at about 2 ppm per year. The U.S. Occupational Safety and Health Administration issues guidelines for indoor workplaces in which elevated CO₂ might be encountered, such as where dry ice is used. The Permissible Exposure Limit is 5,000 ppm over 8 hours (OSHA, 2024). Allen *et al.* (2015) reported evidence of diminished performance on some cognitive tasks among workers in office cubicles when exposed to CO₂ levels above 1,000-1,500 ppm. These levels are far larger than any plausible ambient outdoor value through the end of the 22nd century.

The growing amount of CO₂ in the atmosphere directly influences the earth system by promoting plant growth (global greening), thereby enhancing agricultural yields, and by neutralizing ocean alkalinity. But the primary concern about CO₂ is its role as a greenhouse gas (GHG) that alters the earth’s energy balance. How the climate will respond to that influence is a complex question that will occupy much of this report.

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2 DIRECT IMPACTS OF CO₂ ON THE ENVIRONMENT

Chapter summary:

CO₂ enhances photosynthesis and improves plant water use efficiency, thereby promoting plant growth. Global greening due to increased CO₂ levels in the atmosphere is well-established on all continents.

CO₂ absorption in sea water makes the oceans less alkaline. The recent decline in pH is within the range of natural variability on millennial time scales. Most ocean life evolved when the oceans were mildly acidic. Decreasing pH might adversely affect corals, although the Australian Great Barrier Reef has shown considerable growth in recent years.

2.1 CO₂ and global greening

The growing CO₂ concentration in the atmosphere has the important positive effect of promoting plant growth by enhancing photosynthesis and improving water use efficiency. That is evident in the “global greening” phenomenon discussed below, as well as in the improving agricultural yields discussed in Chapter 10.

2.1.1 Measurement of global greening

“Greening” refers to an increase in the fraction of the Earth’s surface covered by plants. It can be quantified by the “Leaf Area Index” (LAI) measured by satellite. Many studies over the past decade have confirmed a global greening pattern (increase in LAI) attributable to rising CO₂ levels. Zhu *et al.* (2016) was one of the first studies to report that global greening was detectable using satellite sensors. From 1982 to 2011 they detected greening over 25-50 percent of the Earth versus “browning” over only four percent and attributed 70 percent of the greening to rising CO₂ levels (see Figure 2.1).

Zheng *et al.* (2017) confirmed the pattern, noting that greening over thirty years had added 8 percent to global leaf area and that greening was mitigating warming. Greening has been observed globally but Chen *et al.* (2019) noted that China and India were exploiting it through land management changes. Thus, while China accounts for only 6.6 percent of global vegetated area it accounts for 25 percent of global net increase in LAI. Piao *et al.* (2020) noted that greening was even observable in the Arctic.

While plant models predict increased photosynthesis in response to rising CO₂, Haverd *et al.* (2020) reported a CO₂ fertilization rate nearly double model predictions. That is, CO₂ fertilization had driven an increase in observed global photosynthesis by 30 percent since 1900, versus 17 percent predicted by plant models. This indicates that global models of the socioeconomic impacts of rising CO₂ have likely understated the benefits to crops and agriculture. The connection between CO₂ fertilization and agriculture will be discussed in Chapter 9.

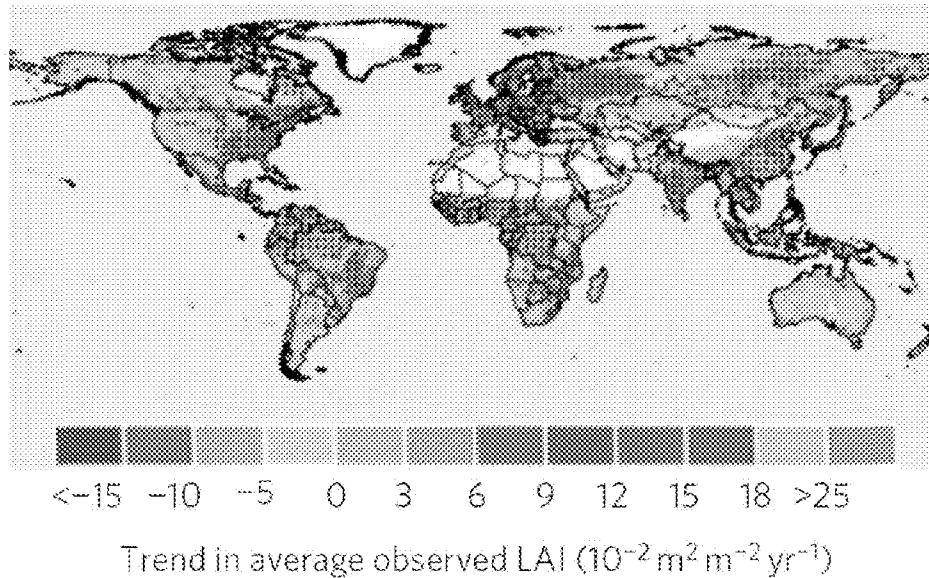


Figure 2.1: Trends in average Leaf Area Index (LAI). Source: Zhu *et al.* 2016 Figure 3.

Finally, Chen *et al.* (2024) surveyed claims that greening had slowed since 2000 due to drought stress. They found instead that faulty satellite sensors were the cause and that the corrected data showed accelerated greening over 55 percent of the globe while browning was accelerating over only 7 percent. In other words, the greening trend continued with no evidence of slowdown, and CO_2 fertilization remained the dominant driver

2.1.2 Photosynthesis and CO_2 levels

Plants build biomass through *photosynthesis*, a process that converts carbon dioxide, water, and light into sugar. The plant enzyme responsible for photosynthesis is Ribulose-1,5-bisphosphate-carboxylase/oxygenase or “Rubisco”. Photosynthesis is initiated when CO_2 is available at the surface of the Rubisco enzyme where it is converted to a molecule with 3 carbon atoms and thereafter incorporated into plant mass. This is referred to as the “C3” process.

Rubisco is estimated to have evolved about 3 billion years ago. Over geological time the Earth’s atmospheric CO_2 levels were usually many times higher than they are today, as shown in Figure 2.2.

About 400 million years ago CO_2 levels were an estimated 2,000–4,000 ppm and were at or above 1,000 ppm for much of the interval from 200 to 50 million years ago (Berner 2006, Judd *et al.* 2024). Over the past 35 million years the level of atmospheric CO_2 has been steadily declining, falling to as low as 170 ppm during glaciations (Gerhart and Ward 2010).

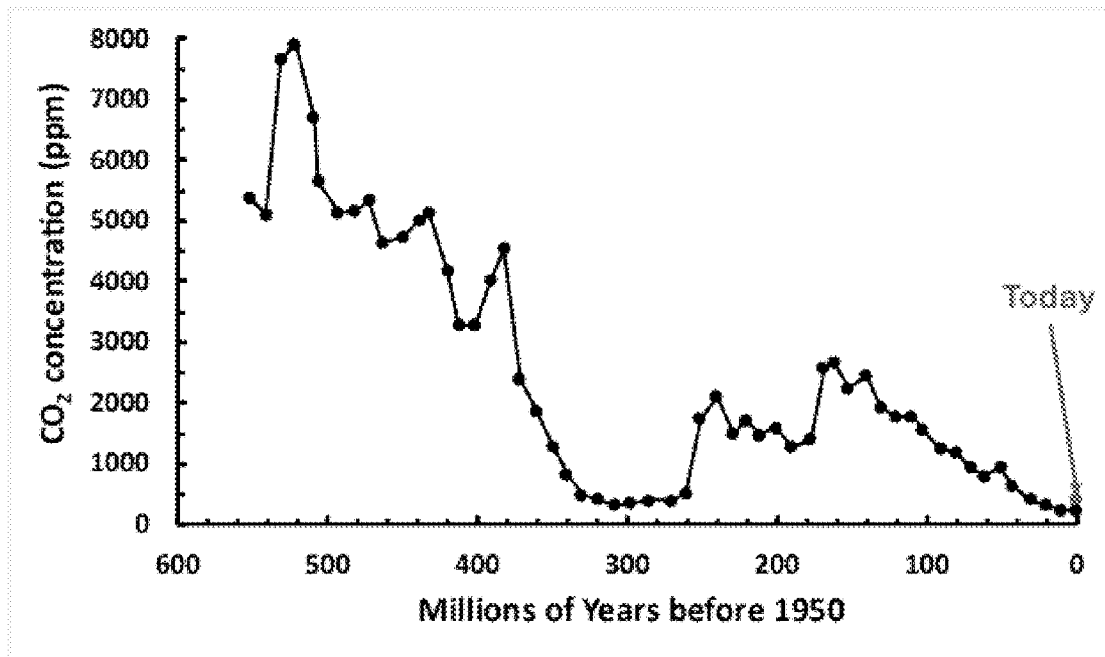


Figure 2.2. Ambient CO₂ levels over the past 550 million years. Today's concentration of 430 ppm is also shown. Source: (Berner 2006)

In response to low-CO₂ conditions some plants evolved another photosynthetic pathway called C₄, in which CO₂ is concentrated in the vicinity of Rubisco, allowing for the C₃ process to function more efficiently. For agricultural purposes the plant categories are:

- C₃: rice, wheat, soybeans and most other crops
- C₄: maize (corn), sugar cane, millet, sorghum

Had atmospheric CO₂ levels continued declining, plant growth would have declined and eventually ceased. Below 180 ppm, the growth rates of many C₃ species are reduced 40-60 percent relative to 350 ppm (Gerhart and Ward 2010) and growth has stopped altogether under experimental conditions of 60—140 ppm CO₂. Some C₄ plants are still able to grow at levels even as low as 10 ppm, albeit very slowly (Gerhart and Ward 2010).

Current CO₂ levels are about 430 ppm, up from 280 ppm in the early 1800s. The positive response of plants to extra CO₂ is illustrated in Figure 2.3, reproduced from Gerhart and Ward (2010). It shows the growth effect of CO₂ on Velvetleaf (*Abutilon theophrasti*) seedlings over 14 days under controlled conditions where only the CO₂ exposure is varied. The gains induced by increasing CO₂ from 150 ppm to 350 ppm continue under a further doubling to 700 ppm.

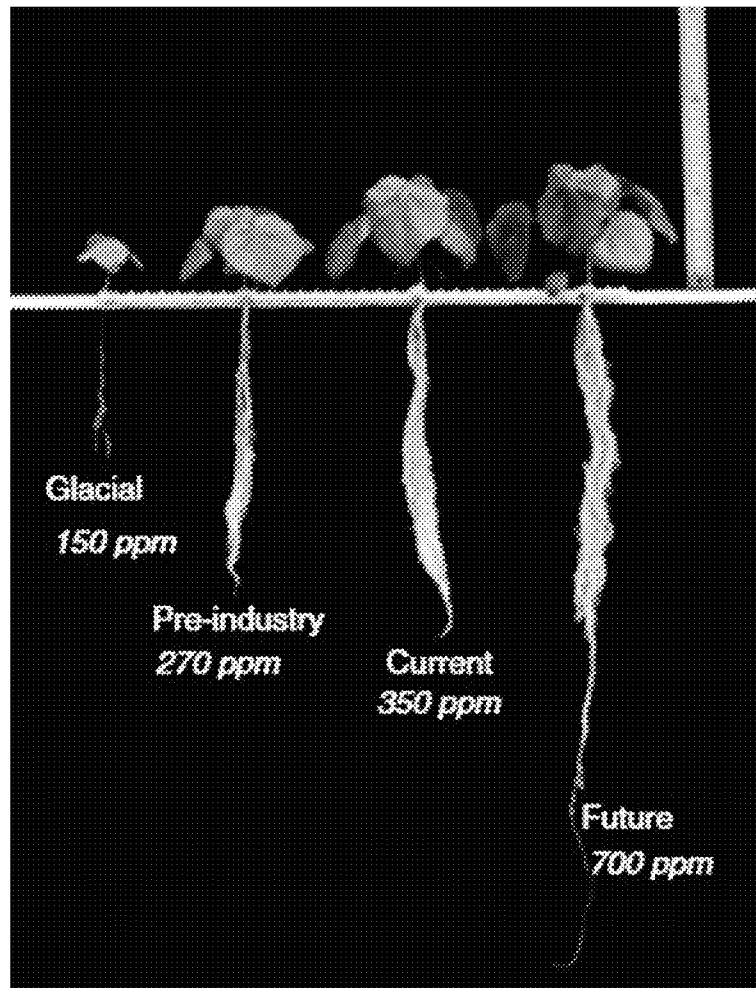


Figure 2.3: growth of *Abutilon theophrasti* after 14 days under identical conditions but for the indicated variations in CO₂ levels. Source: Gerhart and Ward (2010). Note “Current” corresponds to 1988 in image.

Over the past 60+ years there have been thousands of studies on the response of plants to rising CO₂ levels. The overwhelming theme is that plants, especially C3 plants, benefit from extra CO₂. There are two mechanisms by which CO₂ confers a growth benefit:

- Enhanced photosynthesis via the metabolic pathways described above.
- Increased water use efficiency. This arises because plants draw in CO₂ by opening the stomata (pores) on the leaf surface. When CO₂ is scarce the stomata must be kept wide open for long periods, allowing water to evaporate. Under enriched CO₂ conditions the stomata remain closed for longer periods, thus helping the plant retain water longer, and so increasing water use efficiency.

Specific effects of climate change on U.S. agriculture will be reviewed in Chapter 9.

2.1.3 Rising CO₂ and crop water use efficiency

Derying *et al.* (2016) surveyed evidence on crop water productivity (CWP), the yield per unit of water used, drawing attention to the potential for CO₂ both to enhance photosynthesis and to reduce leaf-level transpiration (water loss during leaf respiration). They surveyed all available FACE data (Free Air CO₂ Enrichment—see Chapter 9) on crop yield changes for maize (corn), wheat, rice, and soybean and combined

it with crop model data simulating yield responses as of 2080 under the extreme RCP8.5 emissions scenario in four growing regions (Tropics, Arid, Temperate and Cold) each of which were split into rainfed and irrigated sub-regions. They reported that models without CO₂ fertilization predicted CWP losses in every region, but those were more than offset by CO₂ fertilization so that all regions showed a net CWP gain. Deryng *et al.* (2016) also reported that negative impacts of warming on wheat and soybean yields were fully offset by CWP gains and mitigated by up to 90 percent for rice and 60 percent for maize.

Similarly, Cheng *et al.* (2017) noted that increased global plant growth from 1982 to 2011 due to rising CO₂ uptake was accompanied by such large gains in CWP that global water use by plants had not increased, despite the extra biomass.

Deryng *et al.* (2016) assumed that climate change would “exacerbate water scarcity”. Yet while models do predict that drylands will expand under climate warming, current data show the opposite: greening is happening even in arid areas. Zhang *et al.* (2024) report that due to increased CO₂ levels “increasing aridity in drylands won’t lead to a general loss of vegetation productivity”; at most only 4 percent of currently arid areas will see increased desertification.

2.1.4 CO₂ fertilization benefits in IPCC Reports

The IPCC has only minimally discussed global greening and CO₂ fertilization of agricultural crops. The topic is briefly acknowledged in a few places in the body of the IPCC 6th and earlier Assessment Reports but is omitted in all Summary documents. Section 2.3.4.3.3 of the AR6 Working Group I report, entitled “global greening and browning,” points out that the IPCC Special Report on Climate Change and Land had concluded with *high confidence* that greening had increased globally over the past 2-3 decades. It then discusses that there are variations in the greening trend among data sets, concluding that while they have *high confidence* greening has occurred, they have *low confidence* in the magnitude of the trend. There are also brief mentions of CO₂ fertilization effects and improvements in water use efficiency in a few other chapters in the AR6 Working Groups I and II Reports.

Overall, however, the Policymaker Summaries, Technical Summaries, and Synthesis Reports do not discuss the topic.

2.2 The Alkaline Oceans

2.2.1 Changing pH

A neutral aqueous solution has a pH of 7.0, while one with pH greater than 7.0 is alkaline (also termed basic) and with pH less than 7.0 is acidic. The modern-day global average pH of sea water is estimated to be 8.04 (Copernicus Marine Service 2025), down from an estimated value of 8.2 in pre-Industrial times (Gattuso and Hansson, 2011). As CO₂ concentrations in the atmosphere increased, the oceans absorbed more, which decreases their pH. Depending upon the oceans’ buffering capacity, they are expected to become somewhat less alkaline over time, consistent with the observed decrease in pH.

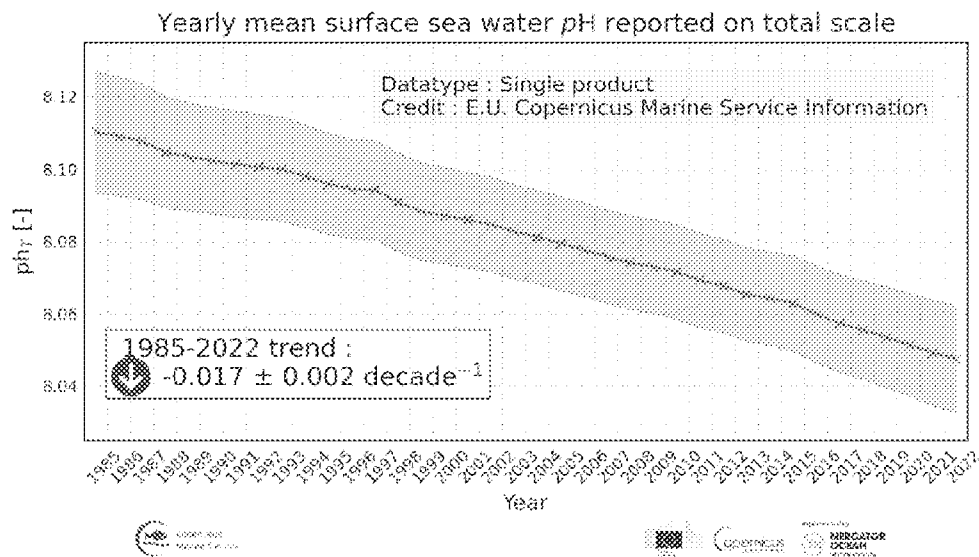


Figure 2.4: Ocean pH 1985 – 2022. Source: Copernicus Marine Service 2025

While this process is often called “ocean acidification”, it is a misnomer because the oceans are not expected to become acidic; “ocean neutralization” would be more accurate. Even if the water were to turn acidic, it is believed that life in the oceans evolved when the oceans were mildly acidic with pH 6.5 to 7.0 (Krissansen-Totton *et al.*, 2018). On the time scale of thousands of years, boron isotope proxy measurements show that ocean pH was around 7.4 or 7.5 during the last glaciation (up to about 20,000 years ago) increasing to present-day values as the world warmed during deglaciation (Rae *et al.*, 2018). Thus, ocean biota appear to be resilient to natural long-term changes in ocean pH since marine organisms were exposed to wide ranges in pH.

2.2.2 Coral reef changes

There are concerns that a decreasing pH of sea water will reduce the calcification rate of coral reefs. But coral reefs already endure large swings in pH, partly due to daily photosynthetic activity in the reef; measured pH values range from 9.4 during the day to 7.5 at night (Revelle and Fairbridge, 1957). De'ath *et al.* (2009) reported that a portion of Australia's Great Barrier Reef (GBR, the world's largest coral reef ecosystem) had experienced a 14 percent decline in calcification since 1990. This was tentatively attributed to increasing water temperature and decreasing pH. But Ridd *et al.* (2013) showed that report to have resulted from a biased data analysis that, when corrected, showed no change in calcification rates. Nevertheless, the alarm produced by the original paper has persisted as evidenced by the large number of published citations (541) to the original study compared to only 11 citations to the correction (as of 30 April 2025).

The most recent annual summary of GBR conditions from the Australian Institute of Marine Science indicates that coral production has rebounded strongly (AIMS, 2023). Figure 2.5 shows the results of the AIMS surveys of hard coral cover, expressed as a percentage of the reef area. Much of the decline in the GBR before 2011 turned out to be due to intense tropical cyclone activity (Beeden *et al.*, 2015) as well as a string of marine heatwaves, agricultural runoff and invasive species (Woods Hole, 2023). Given the reported declines in GBR calcification between 1990 and 2009 and the continued increase in atmospheric CO₂ levels the rebound has surprised some observers.

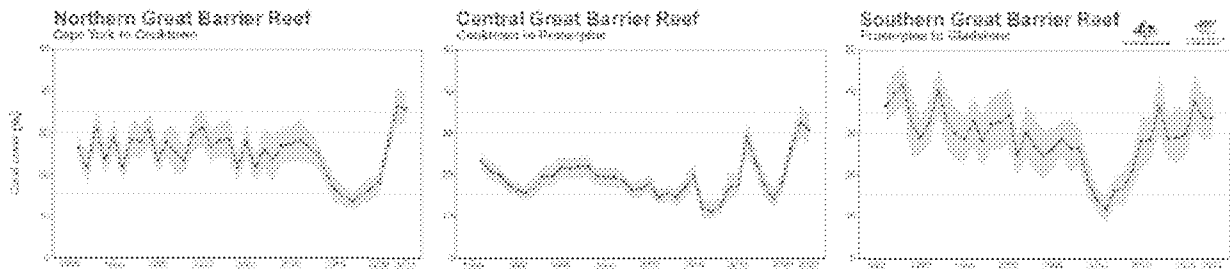


Figure 2.5 Hard coral cover of three regions of the Great Barrier Reef 1985 to 2023. Source: AIMS 2023.

It is being increasingly recognized that publication bias (alarming ocean acidification results preferred by high-impact research publications) exaggerates the reported impacts of declining ocean pH. An ICES Journal of Marine Science Special Issue addressed this problem with an article entitled, *Towards a Broader Perspective on Ocean Acidification Research*. In the Introduction to that Special Issue, H. I. Browman stated, “As is true across all of science, studies that report no effect of ocean acidification are typically more difficult to publish.” (Browman, 2016).

Similarly, a meta-analysis (Clements *et al.*, 2021) of the negative effects of ocean acidification on reef fish behavior found what they called a “decline effect”: initially dramatic conclusions published in prominent journals showing apparently large impacts of acidification tended to be followed up by subsequent studies on larger sample sizes yielding much smaller and typically non-existent effects. They call for their colleagues to improve research practices to counter the “decline effect”:

[The] vast majority of studies with large effect sizes in this field tend to be characterized by low sample sizes, yet are published in high-impact journals and have a disproportionate influence on the field in terms of citations. We contend that ocean acidification has a negligible direct impact on fish behavior, and we advocate for improved approaches to minimize the potential for a decline effect in future avenues of research (Clements *et al.*, 2021).

In summary, ocean life is complex and much of it evolved when the oceans were acidic relative to the present. The ancestors of modern coral first appeared about 245 million ago; as can be seen from Figure 2.2, CO₂ levels for more than 200 million years afterward were many times higher than they are today. Much of the public discussion of the effects of ocean “acidification” on marine biota has been one-sided and exaggerated. There is a known tendency for studies reporting dramatic effects on things like coral cover and fish behavior to get published in high-impact journals and receive widespread press coverage, then subsequent research rebutting those findings receives little attention.

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3 HUMAN INFLUENCES ON THE CLIMATE

Chapter Summary:

The global climate is naturally variable on all time scales. Anthropogenic CO₂ emissions add to that variability by changing the total radiative energy balance in the atmosphere.

The IPCC has downplayed the role of the sun in climate change but there are plausible solar irradiance reconstructions that imply it contributed to recent warming.

Climate projections are based on IPCC emission scenarios that have tended to exceed observed trends. Most academic climate impact studies in recent years are based upon the extreme RCP 8.5 scenario that is now considered implausible; its use as a business-as-usual scenario has been misleading.

Carbon cycle models connect annual emissions to growth in the atmospheric CO₂ stock. While models disagree over the rate of land and ocean CO₂ uptake, all agree that it has been increasing since 1959.

3.1 Components of radiative forcing and their history

3.1.1 Historical radiative forcing

A changing climate has been the norm throughout the Earth's 4.6-billion-year history. The Earth's temperature and weather patterns change naturally over timescales ranging from decades to millions of years. Natural variations in the surface climate originate in two ways. Internal climate fluctuations associated with circulations in the atmosphere and ocean exchange energy, water, and carbon between the atmosphere, oceans, land, and ice. External influences on the climate system include variations in the energy received from the sun and the effects of volcanic eruptions. Human activities influence climate through changing land use and land cover. Humans are also changing the composition of the atmosphere by emissions of CO₂ and other greenhouse gases and by altering the concentration of aerosol particles in the atmosphere.

The earth is warmed by the sunlight it absorbs and is cooled by the heat it radiates to space. Averaged over the Earth's surface, each of these processes involve power flows of about 240 Watts per square meter (W/m²). When they are in balance, there are no net external causes of warming or cooling. Both human and natural influences on the climate alter this balance and so cause the climate to change.

Influences on the Earth's energy balance at the top of the atmosphere are quantified by "radiative forcing", the extent to which they disturb the warming/cooling balance; a positive forcing warms while a negative forcing cools. The IPCC's estimated history of major components of radiative forcing since 1750 is shown in the following two figures from its AR6.

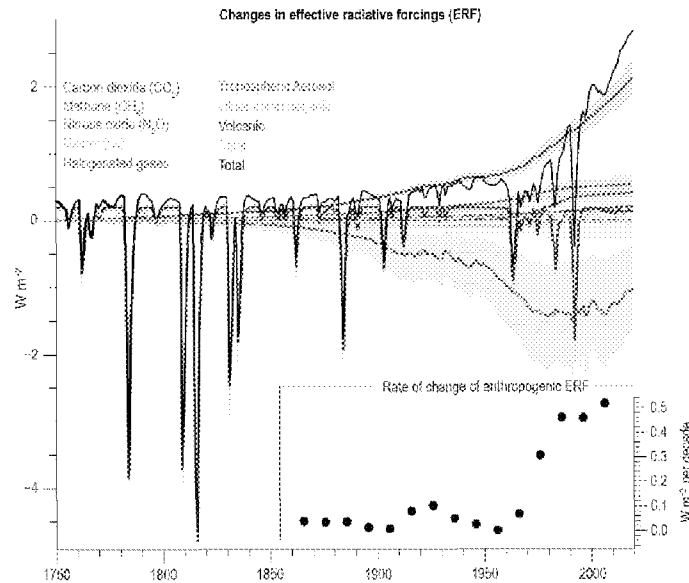


Figure 3.1.1: IPCC estimates of radiative forcing components over time. Shading indicates uncertainty ranges. Source: AR6 WGI Ch2 Fig. 10

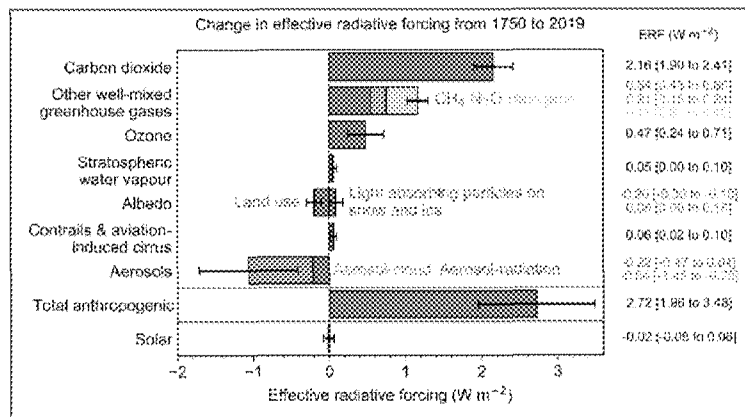


Figure 3.1.2 IPCC estimates of radiative forcing component changes from 1750 to 2019. Source: AR6 WGI Ch 7 Fig. 7-6.

These graphs show that the total radiative forcing is comprised of both natural and anthropogenic components. Carbon dioxide is the largest human influence on the climate and the one most relevant to the influence of fossil fuel use. It exerts a warming influence by decreasing the cooling power of the atmosphere. Emissions of CO_2 are accumulating in the atmosphere, as described in the following section, so that the warming influence is growing. Other greenhouse gases (methane, nitrous oxide, halogens, and ozone) act similarly, currently adding another 75 percent to CO_2 's warming. Aerosols exert an overall cooling effect, although with large uncertainties in the way they catalyze the formation of reflective clouds. As a result, understanding the causes of recent warming requires not just identifying the warming effects of CO_2 , but also the more uncertain cooling effects of aerosols.

The IPCC assesses the change in the radiative forcing by the sun to be negligible, based on their preference for data reconstructions that imply minimal solar change since preindustrial times. But Connolly *et al.* (2021) reviewed sixteen different Total Solar Irradiance (TSI) reconstructions in the literature

covering the years 1600-2000; the reconstructions vary from almost no change in TSI to a relatively large upward trend. Those authors note that the variation in TSI reconstructions combined with variations in surface temperature reconstructions allows for inferences consistent with either no or most 20th century warming being attributable to the sun.

A particularly thorny issue is the gap in TSI data between 1989 and 1991 due to a delay in the launch of a monitor following the Space Shuttle Challenger disaster on January 28 1986. This delay prevented a replacement satellite from being launched in time to overlap with, and its readings to be intercalibrated with, the prior system (Zacharias 2014, Scafetta *et al.* 2019). This is called the ACRIM (Active Cavity Radiometer Irradiance Monitor) gap problem. The question of whether there is an upward trend in TSI over 1978 to 2018 hangs on how the ACRIM data gap is filled. Connolly *et al.* (2021) found that the IPCC's consensus statements on solar forcing were formulated prematurely through the suppression of dissenting scientific opinions.

Another natural radiative forcing component is volcanic aerosols, which exert an episodic cooling influence. Box 4.1 in the IPCC AR6 Report addresses the climate impact of volcanic eruptions, noting three explosive volcanic eruptions that occurred in the first half of the 19th century. This included the 1815 Tambora eruption that resulted in the 'year without summer', with multiple harvest failures across the Northern Hemisphere. There is uncertainty about the sign of the relatively small forcing due to the submarine volcano Hunga Tonga which erupted in 2022 (Jenkins *et al.* 2023, Schoeberl *et al.* 2024).

Figure 3.1.1 shows that the anthropogenic forcing component was negligible before about 1900 and has increased steadily since, rising to almost 3 W/m² today. However, this is still only about 1 percent of the unperturbed radiation flows, making it a challenge to isolate the effects of anthropogenic forcing; state-of-the-art satellite estimates of global radiative energy flows are only accurate to a few W/m².

Natural sources of global energy imbalance other than volcanoes and total solar irradiance (TSI) are not included in these graphs because they remain largely unknown.

3.1.2 Change in atmospheric CO₂ since 1958

Carbon dioxide's warming influence depends on how much "extra" CO₂ accumulates in the atmosphere- *i.e.*, its concentration above the preindustrial value of 280 ppm. The CO₂ level as recorded at the Mauna Loa observatory in Hawaii, generally used as the representative global average concentration, is available online at <https://gml.noaa.gov/ccgg/trends/index.html>. The concentration was about 316 ppm at the start of the record in 1959 and is now about 430 ppm, a 36 percent increase. At the end of the last glaciation CO₂ levels had fallen to about 180 ppm. As discussed in Chapter 2, C3 plants begin dying at CO₂ levels below about 140 ppm and C4 plants at levels below 100 ppm, so if CO₂ levels had continued falling plant life would have been imperiled.

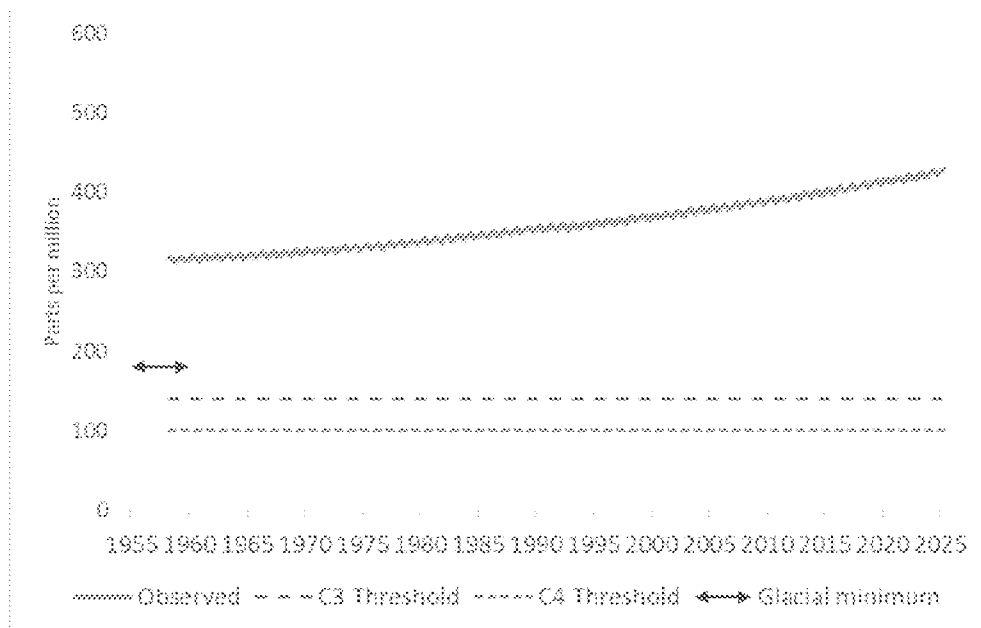


Fig. 3.1.3. Yearly average atmospheric CO₂ concentrations (1959-2025) in ppm measured at Mauna Loa (blue). C3 Threshold: Level below which C3 plants begin dying (140 ppm, see Chapter 2). C4 Threshold: Level below which C4 plants begin dying (100 ppm, see Chapter 2). Glacial minimum: Minimum level during recent glaciations (purple arrow). CO₂ data source: <https://gml.noaa.gov/ccgg/trends/index.html>

The annual increase in concentration is only about half of the CO₂ emitted because land and ocean processes currently absorb “excess” CO₂ at a rate approximately 50 percent of the human emissions. Future concentrations, and hence future human influences on the climate, therefore depend upon two components: (1) future rates of global human CO₂ emissions, and (2) how fast the land and ocean remove extra CO₂ from the atmosphere. We discuss each of these in turn.

3.2 Future emission scenarios and the carbon cycle

3.2.1 Emission scenarios

Assessing the dangers of future GHG emissions requires assumptions about what those emissions will be. Future emissions, and hence human influences on the climate, will depend upon future demographics, economic activity, regulation, and energy and agricultural technologies. Various assumptions about each of those lead to projections of greenhouse gas emissions and concentrations, aerosol concentrations, and changes in land use, which ultimately can be combined into assumptions about anthropogenic radiative forcing.

The great uncertainties about these many factors make it impossible to precisely predict future emissions. Instead, the IPCC has created various sets of scenarios meant to span a plausible range of possibilities for population, economy, and technologies. Recent versions of the scenarios are labeled by a number indicating the anthropogenic radiative forcing expected in 2100 under that scenario. Thus, a scenario labeled with a “6” corresponds to 6 W/m² of human-induced radiative forcing (warming) at the end of the century. (Recall current anthropogenic radiative forcing is about 2.7 W/m².)

Although the IPCC does not claim its emission scenarios are forecasts, they are often treated as such. Comparisons of past scenario groups against observations show that IPCC emission projections tend to overstate actual subsequent emissions. For the IPCC Third and Fourth Assessment Reports a set of emission projections from the *Special Report on Emission Scenarios* was used; these were referred to as the SRES scenarios. McKittrick *et al.* (2012) showed that, when converted to per capita values, the SRES scenario emissions distribution was skewed upwards and incompatible with observed trends. McKittrick and Wood (2013) further showed that global energy market dynamics constrained global per capita CO₂ emissions to an extent not reflected in IPCC scenarios. The bias of the SRES scenarios was confirmed by the later analysis of Hausfather *et al.* (2019) who showed that observed atmospheric CO₂ concentrations tracked the low end of the SRES range and also of subsequent IPCC scenario ranges (Figure 3.2.1).

For AR5 the IPCC developed a new set of scenarios called the Representative Concentration Pathways (RCPs). These were identified by a number representing the increase in forcing and were thus called RCP2.6, RCP4.5, RCP6.0 and RCP8.5. RCP2.6 (implying an anthropogenic radiative forcing in 2100 of 2.6 W/m²) describes a GHG concentration pathway leading to warming well below 2°C. At the other end of the scale RCP8.5 is an extreme outcome implying nearly 5°C warming from 1900 to 2100.

RCP8.5 came to be referred to as the no-policy baseline, or “business-as-usual” scenario in both the academic literature and popular media. It was therefore used to generate the reference outcome supposedly representing the 21st century world in the absence of increasingly stringent emission reduction policies. But RCP8.5 was intended as a low-probability high emissions scenario and its use as a business-as-usual baseline has been criticized as grossly misleading.¹ Hausfather and Peters (2020) writing in a commentary in *Nature*, pointed out that RCP8.5 was developed as an extreme worst-case, and its misuse as a “business as usual” baseline has resulted in a large number of misleading studies and media reporting.

The implausibility of the RCP8.5 scenario was examined by Burgess *et al.* (2021). They noted that RCP8.5 has already diverged from observed trends in energy use and the near future trends diverge sharply from those of the International Energy Agency (IEA), which provides market-based projections of energy use for the coming decades. The IEA trends, which are based on plausible extrapolations of current economic and demographic trends, run below the entire envelope of RCP projections, implying not only that RCP8.5 is dubious, but that even lower emission scenarios are unlikely.

Widespread use of RCP8.5 has created a bias towards alarm in the climate impacts literature. The extent of this problem was confirmed in a literature analysis by Pielke Jr. and Ritchie (2020). They found that some 16,800 scientific papers published between 2010 and 2020 used the RCP8.5 scenario, with about 4,500 of the articles linking RCP8.5 to the concept of “business-as-usual”. Their analysis showed how RCP8.5 was misused not only by individual researchers, but also by influential science agencies like the IPCC and the U.S. National Climate Assessment (USNCA), which has directly led to misleading coverage in prominent media outlets.

¹ This extreme scenario is useful for modelers, since a large forcing generates a large response (warming) making it easier to assess a model’s sensitivity. But that’s very different than claiming it is a plausible future outcome.

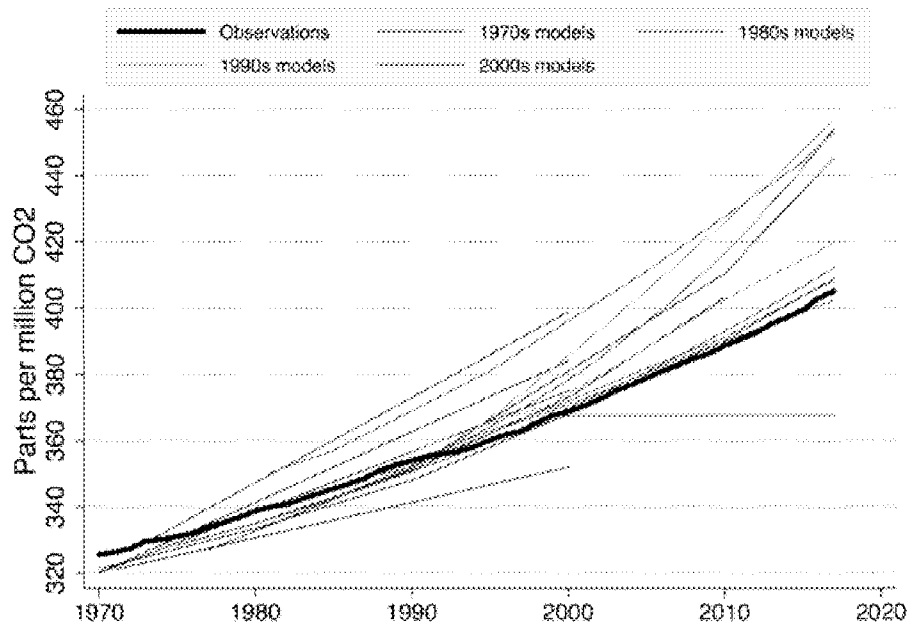


Figure 3.2.1 Comparison of observed atmospheric CO₂ levels (black line) with scenario projections (colored lines, mainly IPCC) since the 1970s. Source: Hausfather *et al.* (2019) Figure S4.

Pielke and Ritchie (2020) reported new studies using RCP8.5 were published at a rate of about 20 per day, with about two per day specifically linking RCP8.5 and “business as usual.” They conclude that the climate research community has spent a decade “committing scientific resources to science fiction” and that “The scientific literature has become imbalanced in an apocalyptic direction.”

The IPCC developed a new set of scenarios for AR6, the “Shared Socioeconomic Pathway” (SSP) scenarios, which have continued the bias shown in the RCP and SRES scenarios. Figure 3.2.2 shows total global observed CO₂ emissions compiled by the International Energy Agency (IEA) merged with the emission projection from the IEA taking account of energy use projections and current policies. The other lines show the range of IPCC SSP scenarios (SSP1-SSP5). As of 2023, global CO₂ emissions have been tracking well below SSP7.0 and are even below SSP2-4.5.

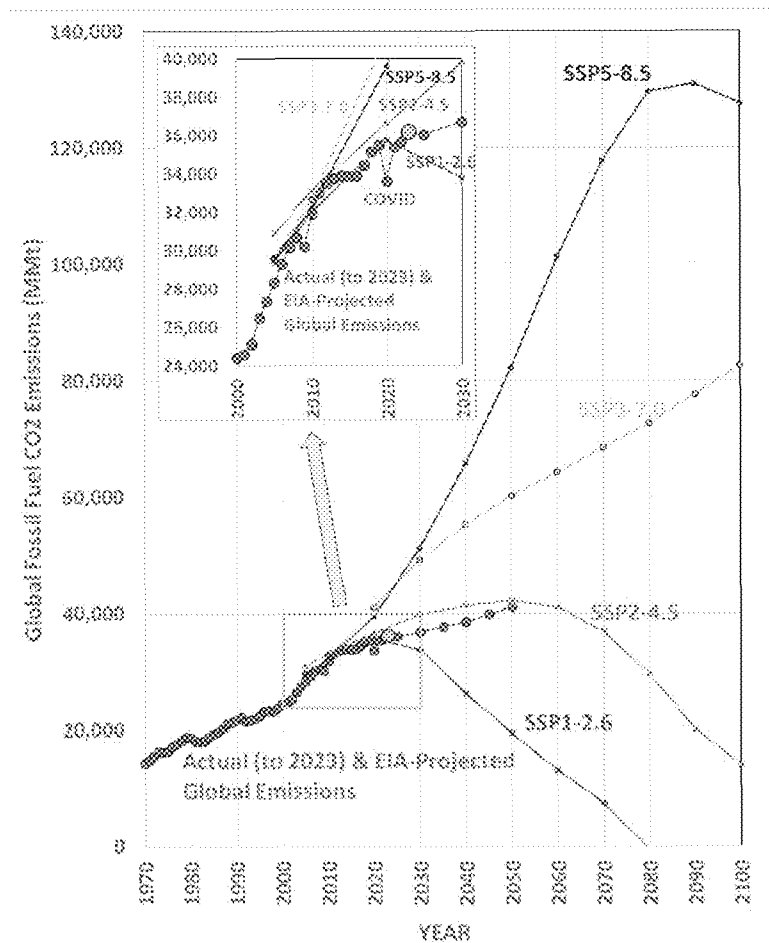


Figure 3.2.2. Observed and projected CO₂ emissions. Source: IPCC (SSP scenarios) and Energy Information Administration (EIA). Green: observed historical emissions and EIA projections. Other lines: SSP1-5. Data source: Friedlingstein *et al.* (2024).

3.2.2 The carbon cycle relating emissions and concentrations

Carbon dioxide emissions from fossil fuel burning (and to a lesser extent deforestation and cement production) have led to steadily increasing CO₂ concentrations in the atmosphere, as shown in Fig. 3.1.3. The relation between emissions and concentration is determined by the global carbon cycle of land and ocean processes that exchange carbon with the atmosphere. Our understanding of these processes was reviewed by Crisp *et al.* (2021).

There are about 850 Gt of carbon (GtC) in the Earth's atmosphere², almost all of it in the form of CO₂. Each year, biological processes (plant growth and decay) and physical processes (ocean absorption and outgassing) exchange about 200 GtC of that carbon with the Earth's surface (roughly 80 GtC with the land and 120 GtC with the oceans). Before human activities became significant, removals from the atmosphere were roughly in balance with additions. But burning fossil fuels (coal, oil, and gas) removes carbon from the ground and adds it to the annual exchange with the atmosphere. That addition (together with a much

² Because CO₂ is chemically transformed through the course of the carbon cycle, it is more convenient to track atoms of carbon rather than molecules of CO₂. One giganne of carbon (GtC) is equivalent to about 3.7 Gt of CO₂.

smaller contribution from cement manufacturing) amounted to 10.3 GtC in 2023, or only about 5 percent of the annual exchange with the atmosphere.

The carbon cycle accommodates about 50 percent of humanity’s small annual injection of carbon into the air by naturally sequestering it through plant growth and oceanic uptake, while the remainder accumulates in the atmosphere (Ciais *et al.*, 2013). For that reason, the annual increase in atmospheric CO₂ concentration averages only about half of that naively expected from human emissions.

To project future CO₂ concentrations in the atmosphere, and hence future human influences on the climate, it is important to know how the carbon cycle might change in the future. The historical near constancy of that 50 percent fraction means that the more CO₂ humanity has produced, the faster nature removed it from the atmosphere. That 50 percent fraction changes somewhat from year to year due to natural carbon cycle imbalances from El Nino, La Nina, and varying weather patterns. There was also a substantial additional reduction in atmospheric CO₂ after the 1991 eruption of Mt. Pinatubo, a curious result that has yet to be explained (Angert *et al.*, 2004).

The main processes that remove excess CO₂ from the atmosphere are increased growth of land vegetation (especially at high latitudes), some increase in the sequestering of carbon in soils, and uptake of CO₂ by the ocean due to the increasing partial pressure of atmospheric CO₂ over that of CO₂ dissolved in the ocean. All twenty land carbon cycle models tracked by the Global Carbon Project (Friedlingstein *et al.*, 2024) show land processes have been removing excess CO₂ at an increasing rate since 1959. This is consistent with a “global greening” phenomenon (Chapter 2.1) observed by satellites since monitoring of global greenness began in 1982.

While land vegetation has been responding positively to more atmospheric CO₂, uptake of extra CO₂ by ocean biological processes remains too uncertain to be measured reliably. Our current understanding of these and many more carbon cycle processes was reviewed by Crisp *et al.* (2021).

CO₂ uptake by land processes

The uptake of extra CO₂ from the atmosphere by land surface processes (as also inferred from global greening) has been modeled with 20 different dynamic global vegetation models, the outputs of which are updated every year by the Global Carbon Project (Friedlingstein, 2024). As seen in Fig. 3.2.3, all of those models agree that vegetation and soils have been sequestering carbon from the atmosphere. But we also see that the long-term trends over 1959 to 2023 (65 years) vary widely between models, by nearly a factor of 7. This demonstrates that there remains considerable uncertainty in how fast land processes are removing CO₂ from the atmosphere, which in turn creates uncertainty in future atmospheric CO₂ concentrations, which then produce uncertainty in climate model simulations of future climate change.

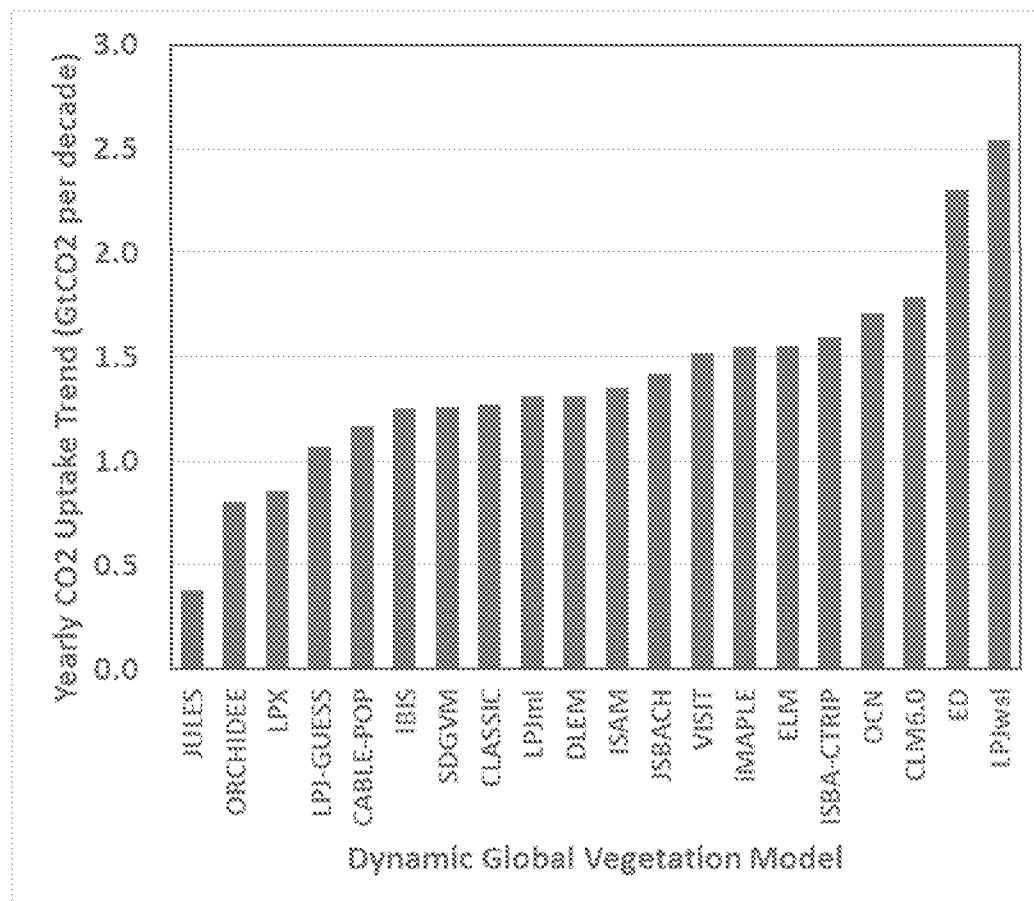


Figure 3.2.3 Trends of annual CO₂ uptake (GtCO₂ per year per decade) by land processes during 1959-2023 simulated by 20 different dynamic global vegetation models periodically reported by the Global Carbon Project (Friedlingstein, 2024).

CO₂ uptake by ocean processes

The uptake of extra CO₂ from the atmosphere by ocean processes has been modeled with 10 different ocean biogeochemistry models, the outputs of which are updated every year by the Global Carbon Project (Friedlingstein, 2024). Like the results from the land models, all of the ocean models agree that the global oceans have been sequestering carbon from the atmosphere at an increasing rate during 1959-2023 (Fig. 3.2.4). Unlike the land models, however, the ocean models show much better agreement with each other, with the model producing the fastest increasing CO₂ uptake being only 65 percent faster than the model with the most slowly increasing CO₂ uptake. In spite of the relative agreement among models, Friedlingstein *et al.* (2022) notes that there is substantial discrepancy between the different methods on the strength of the ocean sink over the last decade, particularly in the Southern Ocean.

Note that the average trend in CO₂ uptake across all land models in Fig. 3.2.3 is 25 percent larger than the average trend in ocean uptake. This suggests land processes are increasing in their ability to remove CO₂ faster than ocean processes are increasing their CO₂ sequestration.

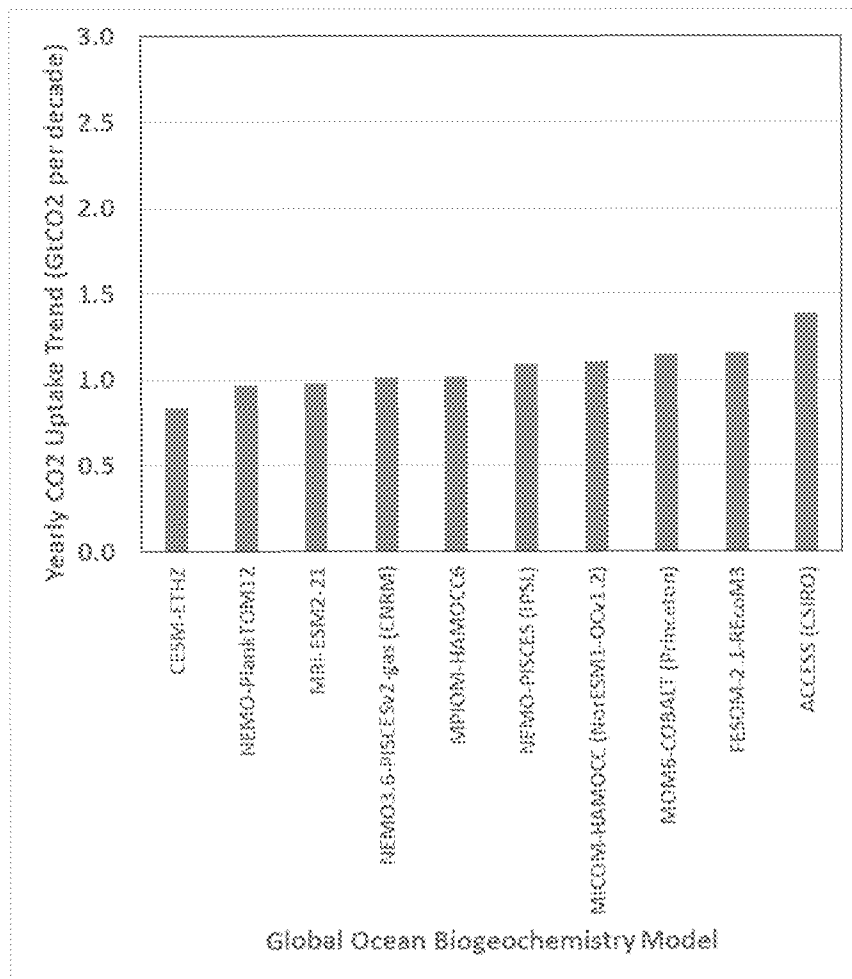


Figure 3.2.4 Trends of annual CO₂ uptake (GtCO₂ per year per decade) by ocean processes during 1959-2023 simulated by 10 different ocean biogeochemistry models periodically reported by the Global Carbon Project (Friedlingstein, 2024).

3.3 Urbanization influence on temperature trends

Historical temperature data over land has been collected mainly where people live. This raises the problem of how to filter out non-climatic warming signals due to Urban Heat Islands (UHI) and other changes to the land surface. If these are not removed the data might over-attribute observed warming to greenhouse gases. The IPCC acknowledges that raw temperature data are contaminated with UHI effects but claims to have data cleaning procedures that remove them. It is an open question whether those procedures are sufficient.

AR6 downplayed this issue by saying (WGI p. 235) that no recent evidence had emerged to alter the AR5 finding that urbanization causes an upward bias of no more than 10 percent in the global land surface warming trend. AR5 (WGI p. 189) also cited the 10 percent upper bound without citing a source. AR4 (WGI p. 244) cited Jones *et al.* (1990) and Peterson *et al.* (1999) as the basis of the claim. Peterson *et al.* had failed to find any difference in trends between rural and urban samples, although their definition of rural included local populations up to 10,000 persons while the relative influence of urbanization begins well below that (Spencer *et al.*, 2025). Jones *et al.* compared rural/urban warming in three regions: Eastern Australia, Eastern China and Western Soviet Union. Their definition of “rural” included towns of up to

10,000 in the former Soviet Union and up to 100,000 in China. They found relative warming biases greater than 10 percent in these areas but conjectured that the urbanization effect averaged over the areas they did not examine would bring the global land bias to under 10 percent of the observed warming trend.

Several papers appeared in print prior to the IPCC AR4 that argued that the warming effect of UHIs added a relatively large (30-50%) component to observed warming and was not simulated by climate models (de Laat and Maurellis 2006, McKittrick and Michaels 2007). These findings were based on correlations between locations of maximum warming over land with locations of maximum socioeconomic development. AR4 asserted (p. 244) that these correlations were an artefact of natural atmospheric circulations and were in fact statistically insignificant, and on that basis set the findings aside. Their claim was controversial because it was presented with no supporting evidence. McKittrick (2010) and McKittrick and Nierenberg (2010) showed that taking into account various conjectured alternative explanations for the correlations did not affect their significance. AR5 (p. 189) conceded that AR4 had provided “no explicit evidence” for its assessment and further acknowledged, based on these papers, that there was “significant evidence for such contamination of the record” i.e. a warming bias in the land record. However as already noted, elsewhere in the AR5 report they carried forward AR4 claim that it was less than 10 percent of observed warming. Further they provided no caution about using the land record for climate measurement despite conceding the evidence for UHI contamination. Recently Soon *et al.* (2023) estimated an urbanization bias in the Northern Hemisphere land record over 1850-2018 sufficient to increase the trend in the blended record from 0.55°C to 0.89°C per century.

Some studies providing evidence against UHI contamination compared warming rates between rural and urban locations (Jones *et al.* 1990, Peterson *et al.* 1999, Wickham *et al.* 2013). It is not known whether such methods would be capable of detecting UHI bias even when present. The influence of UHI warming is logarithmic in population, in other words it is strongest at low population density then levels off as local urbanization expands (Oke 1973, Spencer *et al.* 2025). Hence failure to find a difference in warming rates between urban and rural stations does not prove the absence of UHI contamination. McKittrick (2013) provided an empirical demonstration in which the rural/urban trends were not significantly different in a data set shown on other grounds to be contaminated with UHI bias.

Parker (2006) examined a sample of urban locations and found no difference in trends between subsets partitioned according to nighttime wind speed, concluding on this basis that urbanization could not be a significant factor. Here again the question is whether such a method would find UHI bias even if present. McKittrick (2013) presented an example in which UHI-contaminated data did not exhibit significant trend differences when stratified according to wind speed.

The challenge in measuring UHI bias is relating local temperature change to a corresponding change in population or urbanization, rather than to a static classification variable such as rural or urban. Spencer *et al.* (2025) used newly available historical population archives to undertake such an analysis and found evidence of significant UHI bias in U.S. summertime temperature data.

In summary, while there is clearly warming in the land record, there is also evidence that it is biased upward by patterns of urbanization and that these biases have not been completely removed by the data processing algorithms used to produce climate data sets.

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PART II: CLIMATE RESPONSE TO CO₂ EMISSIONS

4 CLIMATE SENSITIVITY TO CO₂ FORCING

Chapter Summary

There is growing recognition that climate models are not fit for the purpose of determining the Equilibrium Climate Sensitivity (ECS) of the climate to increasing CO₂. The IPCC has turned to data-driven approaches including historical data and paleoclimate reconstructions, but their reliability is diminished by data inadequacies.

Data-driven ECS estimates tend to be lower than climate model-generated values. The IPCC AR6 upper bound for the likely range of ECS is 4.0°C, lower than the AR5 value of 4.5°C. This lowering of the upper bound seems well justified by paleoclimatic data. The IPCC AR6 lower bound for the likely range of ECS is 2.5°C, substantially higher than the AR5 value of 1.5°C. This raising of the lower bound is less justified; evidence since the AR6 finds the lower bound of the *likely* range to be around 1.8°C.

4.1 Introduction

The climate's response to increasing concentrations of CO₂ is central to the scientific debate on anthropogenic climate change, and so also to the public debate on “climate action.” The simplest measure of that response is the rise in the global average surface temperature, quantified by the Equilibrium Climate Sensitivity (ECS). ECS is defined as the amount of warming expected in response to a doubling of CO₂ from its pre-industrial concentration of 280 ppm, after all climate components have had time to adjust. Some components, like temperatures in the lower atmosphere (troposphere), adjust rapidly, while others such as the deep ocean and cryosphere might take as long as centuries. A related measure, the Transient Climate Response (TCR), better describes the shorter time scales; it is defined as the amount of warming when the CO₂ concentration is doubled by rising one percent annually for 70 years.

The 1979 Charney Report for the U.S. National Academy of Sciences (National Research Council 1979) proposed that the most likely ECS was $3.0 \pm 1.5^\circ\text{C}$. The IPCC repeatedly reaffirmed that range with only minor variations until its most recent AR6. AR5 termed 1.5–4.5°C as the *likely* range (66 percent probability) and stated that ECS is *extremely unlikely* (95 percent probability) to be below 1.0°C and *very unlikely* (90 percent probability) to exceed 6.5°C.

The uncertainty in ECS has remained stubbornly wide, despite many individual studies that claimed to narrow it (Hausfather 2023). Most recently, AR6 narrowed the *likely* range to 2.5–4.0°C and deemed the *very likely* range to be 2.0–5.0°C. This narrowing on the low end is disputed, as will be discussed below.

Uncertainties in ECS are highly consequential for policy making. As will be discussed in Chapter 11, economic models use ECS values to project the costs of CO₂ emissions. The traditional value (3.0 °C) has typically yielded modest global social costs of CO₂ emissions, sufficient to justify some policy actions, but mostly deferred to later in this century. If ECS is very high (above 4.5°C) immediate aggressive emission controls become more imperative, whereas no CO₂ emission controls are economically justifiable for ECS below 2.0°C (Dayaratna *et al.* 2016, 2020). Obtaining a precise estimate is impossible, so policy making needs to account for the uncertainty.

By itself, the equilibrium warming effect of a doubling of atmospheric CO₂ is slightly more than 1°C (Soden and Held 2006). Larger values of ECS arise from positive feedbacks that amplify the CO₂ warming. Water vapor feedback is positive: a warmer atmosphere might have more water vapor, which itself is a powerful greenhouse gas. Warmer temperatures also result in less snow and sea ice cover, allowing the

Earth to absorb more of the sun's radiation. Some simple estimates of these feedbacks increase the ECS to around 2°C (Sherwood *et al.*, 2020). Larger values of ECS are associated with positive cloud feedbacks.

Climate scientists use multiple lines of evidence to determine the Equilibrium Climate Sensitivity:

- Climate model simulations
- Historical observations
- Paleoclimatic reconstructions
- Process understanding of feedbacks

4.2 Model-based estimates of climate sensitivity

The ECS ranges given in IPCC AR4 and AR5 were obtained primarily by examining the behavior of large-scale climate models, also called General Circulation Models (GCMs). However, the IPCC changed course in its AR6 when it turned to a more direct data-driven methodology. Here we discuss some of the pitfalls of using GCMs to try to determine the Earth's climate sensitivity.

In principle, ECS is an emergent property of GCMs—that is, it is not directly parameterized or tuned, but rather emerges in the results of the simulation. Otherwise plausible GCMs and parameter selections have been discarded because of perceived conflict with an expected warming rate, or aversion to a model's climate sensitivity being outside an accepted range (Mauritsen *et al.* 2012). This practice was commonplace for the models used in AR4; modelers have moved away from this practice with time. However, even in a CMIP6 model, Mauritsen and Roeckner (2020) state the following regarding their Max Planck Institute (MPI) climate model (emphasis added):

“We have documented how we tuned the MPI-ESM1.2 global climate model to match the instrumental record of warming; an endeavor which has clearly been successful. Due to the historical order of events, the choice was to do this practically by **targeting an ECS of about 3 K using cloud feedbacks**, as opposed to tuning the aerosol forcing.”

In other words, the MPI modelers chose an ECS value of 3°C and then tuned the cloud parameterizations to match their intended result.

As noted, direct warming from CO₂ doubling is only about 1°C (Soden and Held 2006); further warming arises from climate feedbacks that are not explicitly resolved by the GCM but rely on parameterizations of physical processes. Higher values of ECS arise primarily from assumed positive cloud feedbacks, whereas the magnitude and even the sign of the feedbacks are very uncertain. Elements of cloud feedback include changes in the latitudinal distribution of clouds, changes in the distribution of cloud height (changes in low versus high clouds), changes to the phase of clouds (ice versus liquid), changes in cloud particle size (associated with changes in concentration and/or composition of aerosol particles), changes in the precipitation efficiency of clouds, and even changes in how clouds are distributed over the daily solar cycle (Curry and Webster, 1999). It is difficult for GCMs to simulate any of these processes correctly owing to their small scale, let alone predict how they will change in the future. Further, cloud processes modulate the magnitudes of the water vapor, lapse rate, and the surface albedo feedbacks.

ECS can be determined from climate model simulations by doubling the concentration of CO₂ and allowing several centuries for the warming to equilibrate. To avoid the need for such long simulations, “effective climate sensitivity” is commonly evaluated from a 150-year simulation in response to a sudden quadrupling of CO₂.

The spread of ECS values from the CMIP5 ensemble of climate models used in AR5 was 2.0–4.7°C; that range increased for the CMIP6 models used in AR6 to between 1.8 and 5.7°C (Chen *et al.*, 2021, Scaffeta 2021, see Figure 4.1). Far from resolving the model-based climate sensitivity the range appears to be growing. The main cause of the overall upward shift in ECS in CMIP6 relative to CMIP5 is a larger positive cloud feedback, driven by changes to the cloud parameterizations in many CMIP6 models (Zelinka *et al.*, 2020)

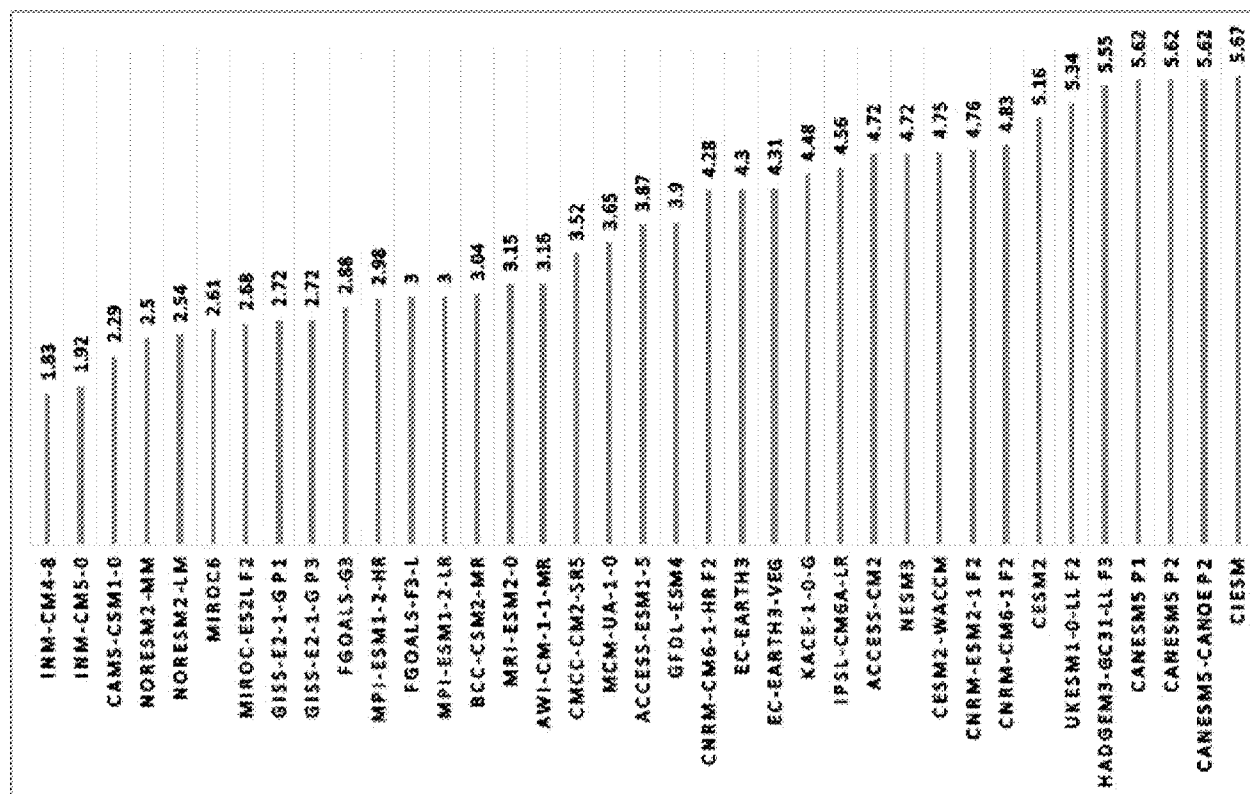


Figure 4.1 Equilibrium Climate Sensitivities in °C of 37 climate models from the CMIP6 ensemble. Identifiers for the various models appear along the horizontal axis. From (Scaffeta, 2021)

Because of concerns about model tuning and the high sensitivity to cloud parameterizations, the IPCC AR6 (2021) did not rely on climate model simulations in their assessment of climate sensitivity, relying instead on data-driven methods.

4.3 Data-driven estimates of climate sensitivity

Climate sensitivity can also be estimated from instrumental records of surface temperatures and ocean heat content, combined with estimates of how climate forcings (e.g., greenhouse gases, solar, volcanoes, aerosols) have changed in the past (Otto *et al.*, 2013). Using this information, a simple empirical model called an Energy Balance Model can be employed. It requires estimating a feedback parameter whose uncertainties are highly amplified in the resulting ECS (Roe and Baker, 2007).

The accuracy of the data-driven methods depends on the quality of the input data. Assumptions are needed about ocean heat storage, and good data is only available for recent decades. The greatest source of uncertainty is the amount and composition of aerosol particles and their interactions with cloud radiative properties (the so-called aerosol indirect effect; see Figures 3.1.1, 3.1.2). Climate models exhibit warming in response to GHGs but cooling in response to aerosols (Schwartz *et al.*, 2007). Observed 20th century warming can be shown to be consistent either with low ECS and low aerosol cooling, or high ECS and high aerosol cooling. Since fossil fuel use adds both GHGs and aerosols to the atmosphere, both effects need to be estimated to isolate the warming effect of CO₂.

Paleoclimate proxies are also used to evaluate the sensitivity of past climates by comparing paleoclimate changes in the Earth's temperatures to estimates of changes in forcings. The two most informative periods are the last glacial maximum (around 20,000 years ago), which was about 3–7°C colder than today, and a mid-Pliocene period (roughly three million years ago), which was 1–3°C warmer than today. The limits on cooling during the last glacial maximum give the best single evidence that high values of climate sensitivity are unlikely. However, paleoclimate estimates are associated with very large uncertainties in the estimated temperatures and forcings. Further, estimates of climate sensitivity based on past climate states might not be applicable to the current state of the climate system.

A recurring theme in the climate literature is that ECS estimates based on historical data are smaller than ECS estimates inferred from climate models (Sherwood and Forest 2024). About 15 estimates based on historical data appeared in the peer-reviewed literature between 2012 and 2024 yielding ECS best estimates between 1.0°C and 2.5°C, although critics have questioned some of the methods and the data quality. For AR6, the IPCC placed primary weight on the results of Sherwood *et al.* (2020) that combined historical data and paleoclimate proxies with the process-based approach and yielded a best estimate of 3.1°C with a *likely* range of 2.6–3.9°C. Lewis (2022) raised a number of concerns about this result, including methodological errors, outdated input values, and use of subjective Bayesian priors in the analysis. Lewis' analysis found that climate sensitivity is estimated to be much lower and better constrained than in the Sherwood *et al.* analysis – median 2.2°C (1.8–2.7°C in the 17–83 percent *likely* range, and 1.6–3.2°C in the 5–95 percent *very likely* range). The IPCC AR6 estimated only a 5 percent probability that ECS was below 2.3°C, whereas Lewis estimated it to be over 50 percent. The most recent publications on the debate between Sherwood *et al.* and Lewis further defend their respective positions: Sherwood and Foster (2024) and Lewis (2025).

An argument emphasized in AR6 is that data-driven ECS estimates might understate the future warming response to GHGs because of a so-called “pattern effect” (Forster *et al.*, 2021). The tropical Pacific is believed to strongly influence the overall efficiency with which the Earth radiates heat to space, but some regions remove heat more efficiently than others. If the west-to-east temperature gradient in the tropical Pacific is weakened in a warming climate, warming would concentrate where heat is less efficiently removed, raising ECS.

Most climate models simulate that rising GHGs will weaken the west-east temperature gradient, which led the IPCC in AR6 to conclude that data-driven ECS estimates understated the *future* ECS value. However, Seager *et al.* (2019) pointed out that, contrary to models, the west-east temperature gradient has been strengthening over time. They further argued that the mechanism predicting otherwise in climate models was based on a faulty characterization of oceanic dynamics and there is no reason to expect the gradient to weaken. A similar argument was recently made by Lee *et al.* (2024), who concluded that “the trajectory of the observed trend reflects the response to increasing GHG loading in the atmosphere”; in other words, GHG warming should lead to a future strengthening rather than a weakening of the temperature gradient. Increased efficiency of atmospheric cooling implies, if anything, that the future ECS in a warming climate might be *lower* than current estimates.

4.4 Transient Climate Response

The Transient Climate Response (TCR) provides a more useful observational constraint on climate sensitivity. TCR is the global temperature increase that results when CO₂ is increased at an annual rate of 1 percent over a period of 70 years (*i.e.*, doubled gradually). Relative to the ECS, observationally determined values of TCR avoid the problems of uncertainties in ocean heat uptake and the fuzzy boundary in defining equilibrium arising from a range of timescales for the longer-term feedback processes (*e.g.*, ice sheets). TCR is more generally related to peak warming and better constrained by historical warming, than ECS. IPCC AR6 judged the *very likely* range of TCR to be 1.2–2.4°C. In contrast to ECS, the upper bound of TCR is more tightly constrained. For comparison, the TCR values determined by Lewis (2023) are 1.25 to 2.0°C, showing much better agreement with AR6 values than was seen in a comparison of the ECS values.

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